Cranfield University

Dzung V. Nguyen

The Determinants of Merger Arbitrage Return

An Empirical Analysis in the UK context

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Dzung V. Nguyen

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Supervisor: Professor P.S. Sudarsanam

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ABSTRACT

This thesis explores the magnitude and the determinants of the return to the merger arbitrage strategy in the UK context. We perform empirical analysis of the three hypotheses namely the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageurs' role hypothesis. First, in the risk-based hypothesis, using a sample of 1105 UK cash and stock mergers from 1987 to 2007, we find that the strategy generates significant positive return in excess of the systematic risk adjustment benchmark. The result is robust to a range of methods to control for systematic risk. The finding is consistent with the existing evidence from other markets. As for the risk-return characteristics of the strategy, in contrast to the US evidence, we find little evidence supporting the non-linear pattern. This finding is in line with the restrictions on bidder's ability to abandon the bid imposed by UK Takeover Code. This finding, combined with the evidence in the US market (strong non-linearity) and the Australian market (no non-linearity), demonstrates the impact of takeover regulation on the risk-return characteristics of the strategy.

Second, in the limited arbitrage hypothesis, we test the impact of different types of risks, costs and constraints (other than systematic risk) on the arbitrage return. We find that transaction costs are one of the important drivers of the cross-sectional variation of the arbitrage return. The result is robust to 4 different proxies for transaction costs, that is, firm size, price level, dollar trading volume, and frequency of zero return days. Holding costs are found to be an important determinant of the return. Idiosyncratic risk, the most important type of holding costs, contributes significantly to the source of the arbitrage return. We find that short-sale constraints appear to be another important holding cost that the arbitrageurs concern about. The result about the impact of short-sale constraints is, however, still inconclusive due to the small sample size. We also test the agency-based model of limited arbitrage hypothesis proposed by Shleifer and Vishny (1997) but find no supporting evidence.

Third, in the arbitrageurs' role hypothesis, utilizing a manually collected dataset to identify arbitrageurs and their holding of target stocks, we examine how different roles that arbitrageurs play in the takeover process help explain the source of the return to the strategy. We find that arbitrage holding is significantly related to arbitrage return after a host of factors that can determine the bid outcome and the market's assessment of the bid outcome are controlled for. This finding shows that the arbitrageurs are better than the average investors in the market in picking better takeover bids, the investment in which yields higher risk-adjusted return. In contrast to the US evidence, arbitrage holding is found to be negatively related to bid premium and has no impact on the probability of bid success. The difference between this finding and the US evidence may be attributable to the much more stringent UK disclosure rule during the takeover period compared to the US counterpart.

Overall, our study, while providing evidence broadly in support of significant return to the merger arbitrage strategy, also highlights the importance of recognizing the impact of the takeover regulation on such return.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: INTRODUCTION

Background for the research

After a takeover bid is announced, there is an inherent uncertainty regarding the outcome of the bid. There is a possibility that the bid might be delayed, called off, or the terms of the bid are revised. Merger arbitrage, also known as risk arbitrage, is the investment strategy designed to profit from the uncertainty surrounding the outcome of a takeover bid.

Research on the determinants of the return to the strategy can be grouped under three hypotheses namely the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageurs' role hypothesis. The primary concern under the risk-based hypothesis is the extent to which systematic risk can help explain the return to the strategy and the risk-return characteristics of the strategy. Empirical studies on this hypothesis unanimously document that the strategy generates significant positive return in excess of the systematic risk benchmark. As far as the risk-return characteristics of the strategy are concerned, the return to the arbitrage portfolio is found to be related to the market risk in a non-linear way. In particular, the strategy has zero market risk in normal market condition but has significant positive market risk during serve market downturn. The evidence supporting the non-linear pattern, however, is confined to the US market. The study in the Australian market reports no supporting evidence for the non-linear pattern.

The limited arbitrage hypothesis and the arbitrageurs' role hypothesis complement the risk-based hypothesis by proposing plausible explanations for the existence of the excess return to the strategy, the part of the arbitrage return unexplained by systematic risk. Under the limited arbitrage hypothesis, the excess return exists due to the additional costs, risks and constraints (other than systematic risk) that the arbitrageurs face in implementing the strategy. Under the arbitrageurs' role hypothesis, the arbitrageurs earn excess return thanks to their ability to select the best takeover bids for the arbitrage portfolio or, most interestingly, to their ability to influence the final outcome and the terms of the bid. The empirical evidence for these two hypotheses is scanty, inconclusive and limited to US samples.

Most of the empirical research on the determinants of the merger arbitrage return is restricted to the US market. The evidence outside the US is scarce. To our best knowledge, there are only two studies for the Canadian and Australian market respectively. The common feature of these two studies is that the sample size is very small compared to the US samples. Specifically, the Canadian study only employs a sample of 37 takeover bids for the year 1997 and the Australian study's sample size is 193 takeover bids from 1991 to 2000. Due to their small sample size, the results of these two studies might not be robust.

Factors influencing the return to the merger arbitrage strategy include takeover regulatory rules that affect the timing, disclosure of information, revision of offer terms, ability of the bidder to withdraw the offer, and the timetable for the merger process to be completed. These regulatory rules are different between the US and other countries. Thus, the results of the research in the US are not easily generalizable to other markets. This represents a gap in the literature.

This doctoral study seeks to fill this gap by investigating the profitability of the strategy and the factors that determine the return to the strategy in the UK market. As the UK is the second most active merger and acquisition market in the world, the size of the UK sample employed in this study is much larger than other non-US samples. Hence, this study presents the first rigorous empirical study on merger arbitrage in a market other than the US market. The UK takeover regulatory regime provides a distinctive setting different from the US regime. This study is the first to examine the impact of takeover regulation on the factors that determine merger arbitrage return. The primary research question is:

What is the magnitude of merger arbitrage return in the UK market and what are the factors that determine the return?

To tackle the research question, we conduct three empirical projects testing the three hypotheses in the UK market. In the first project testing the risk-based hypothesis, we estimate the return to the strategy and examine how systematic risk can help explain the source of the return. Given the extant empirical evidence, it is expected that the strategy will generate positive return in excess of a risk-adjusted benchmark return. However, the risk-return pattern during bull and bear markets is expected to be different in the UK from that in the US due to differences in their takeover regulations. The other two projects are aimed at uncovering the factors behind the excess return to the strategy. In the second project, we test the limits to arbitrage model in terms of the risks and costs that limit the arbitrage activities. In the third project, we focus on the roles that the arbitrageurs play during the takeover process and test for their impact on merger arbitrage return.

Summary of findings

Risk-based hypothesis

With a sample of 1105 UK cash and stock takeover bids over the period of 1987-2007, we find that the strategy is profitable on a risk-adjusted basis. Utilizing three asset pricing models, namely the Capital Asset Pricing Model (CAPM), the Fama and French (1993) three-factor model and the Carhart (1997) four-factor model, we find the risk-adjusted return to the merger arbitrage portfolios to be around 0.5-0.6% per month or 6.17-7.44% per annum. The result using the contingent-claim approach to control for any possible non-linear risk-return pattern is similar. This result is consistent with the findings in other markets. However, unlike in the US, our results do not show any strong non-linearity in the returns between bull and bear markets. The evidence for a positive slope between arbitrage returns and market returns in bear markets and a flat slope in bull markets, found in the US, is extremely weak or non-existent in the UK. This difference, we argue, is attributable to the difference in takeover regulations.

The major contribution of the study is to show how takeover regulations can affect the risk-return characteristics of the merger arbitrage strategy and to provide empirical evidence of such impact. The finding that there is little evidence supporting the non-linear risk-return pattern of the strategy in the UK is in line with the restrictions on bidder's ability to abandon the bid imposed by UK Takeover Code. Combined with the evidence in the US market (strong non-linearity) and the Australian market (no non-linearity), the impact of takeover regulation is confirmed.

Limited arbitrage hypothesis

The first project examines how systematic risk can help explain the source of the merger arbitrage return. The empirical result in the first project, combined with the findings in other markets, indicates that the strategy can persistently generate positive risk-adjusted return or abnormal return. The second project looks at different types of risks and costs (other than the systematic risk) that the arbitrageurs face and tests how these risks and costs account for the return to the strategy. Due to additional data requirement, this project employs a smaller sample of takeover bids than the sample of the first project. The sample of this second project includes 653 takeover bids from 1997 to 2007.

First, we test two competing theories under the limited arbitrage hypothesis namely the price pressure theory and the arbitrage costs theory. These two theories propose contrasting explanations about why the return in excess of the benchmark for systematic risk or abnormal return persists. The price pressure theory is grounded up on the agency-based limited arbitrage model proposed by Shleifer and Vishny (1997). The model postulates that the real-world arbitrageurs are likely to be capital constrained and might not be able to absorb the selling pressure created by the target shareholders who do not want to bear the deal completion risk. As a consequence, the target stock price may fall well below its inefficient level enabling the arbitrageurs to earn abnormal return. Thus, under the price pressure theory, the source of the arbitrage excess return is the inefficiency in the pricing of the merger stocks. The arbitrage cost theory, by contrast, proposes that positive excess return exists because the real-world arbitrageurs have to face different types of risks and costs other than systematic risk. The excess return compensates the arbitrageurs for bearing these additional risks and costs. In the spirits of the arbitrage cost theory, there is no inefficiency in the pricing of the merger stocks. The arbitrageurs earn a fair return commensurate with the risks and costs that they have to face.

The findings of this project show very little support for the price pressure theory. Using a range of proxies for price pressure and transaction costs, we find that the transaction cost effect dominates the price pressure effect. The differences in the transaction costs that the arbitrageurs incur appear to be one of the important forces behind the cross-sectional variation of the merger arbitrage abnormal return. As transaction costs are one type of arbitrage costs that the arbitrageurs have to face, this result is consistent with the arbitrage cost theory.

The other type of arbitrage costs namely holding costs is found to have significant impact on the arbitrage excess return. Idiosyncratic risk, one of the most important holding costs, significantly contributes to the source of the arbitrage return. Excess return increases with the level of idiosyncratic risk as the arbitrageurs require higher return to compensate for the risk. Finally, we find that short-sale constraints appear to be another important holding cost that the arbitrageurs concern about. Due to the small sample size, the impact of short-sale constraints is still inconclusive nevertheless.

Arbitrageurs' role hypothesis

Utilizing a manually collected dataset to identify arbitrageurs and their holding of the target stocks and a range of methods to tackle the possible endogeneity problem, the third project examines how the roles that arbitrageurs play in the takeover process help explain the return to the strategy. The study in the US context by Hsieh and Walkling (2005) documents that the arbitrageurs have superior skills in selecting the best takeover bids for their portfolio and have the ability to alter the course of the takeover process. The authors report that the presence of arbitrageurs is associated with higher bid premium and higher chance of bid success. The findings provide a good demonstration of the theoretical prediction propounded by Cornelli and Li (2002). The theoretical model is, however, predicated on the assumption that arbitrageurs have the ability to hide their identity during their trading with other investors.

The stricter disclosure rules during the takeover period in the UK than those in the US, where the previous studies were conducted, provide an excellent setting to investigate the importance of the assumption in shaping the model's prediction. Under the UK laws, it is very difficult for the arbitrageurs to trade in the target stock without revealing their positions. If the assumption is of material importance, we would expect a very different relationship between the presence of arbitrageurs and arbitrage returns, bid premium and the probability of bid success.

We find that arbitrage holding is significantly related to arbitrage excess return in a non-linear way. Below a certain arbitrage holding threshold, the arbitrage excess return increases with arbitrage holding; above the threshold, arbitrage excess return decreases with arbitrage holding. The relationship between arbitrage excess return and arbitrage holding remains significant after a host of factors that can determine the bid outcome and the market's assessment of the bid outcome are controlled for. This indicates that the arbitrageurs are better than the average investors in the market in picking the best bids that yield higher risk-adjusted return for the arbitrage portfolios.

In contrast to Hsieh and Walkling's (2005) finding, we report a significant negative relationship between arbitrage holding and bid premium. The fact that the UK arbitrageurs are forced to reveal their trading position too soon contributes to this relationship. If the bidder knows that the short-term arbitrageurs are already in the game, it would have no incentive to raise the offer price ex ante or revise the bid upward ex post to attract more arbitrageurs into the contest as predicted by Cornelli and Li (2002). In fact, the bid premia in those bids, where the arbitrageurs have to reveal themselves before the bid announcement date, are significantly lower than the premia in those bids, where the arbitrageurs do not have to. Finally, we find that arbitrage holding is not significantly related to the probability of bid success. The stark difference in the result, when the anonymity assumption is somewhat violated, raises the need for future theoretical models to incorporate a weaker version of the assumption.

Overall, our study, while providing evidence broadly in support of significant return to the merger arbitrage strategy, also highlights the importance of recognizing the impact of the takeover regulation on such return.

Structure of thesis

The remainder of the thesis is organized as follows. Chapter 2 surveys the extant literature to identify the factors that contribute the source of the return, based on which the chapter proposes the research question. Chapter 3 presents the data and methodology issues that are common to all three empirical projects. Chapter 4 reports the results of the empirical tests of the risk-based hypothesis. Chapter 5 presents the tests of the limited arbitrage hypothesis. Chapter 6 discusses the result of the empirical analysis of the arbitrageurs' role hypothesis. Chapter 7 concludes the thesis.

Chapter 2: LITERATURE REVIEW

2.1 Introduction

Many studies on merger arbitrage conclude that the strategy can generate substantial positive return. In this chapter, we survey the extant literature to identify the relevant factors that contribute to the source of the return. On that basis, we explore the gaps in the existing research and propose our research question to address such gaps. The review of the literature in this section also serves as a guideline for the empirical work in the following chapters.

This chapter is structured as follows. Section 2.2 describes a typical arbitrage investment. Section 2.3 presents the theoretical framework on the determinants of the return to the strategy. Section 2.4 discusses the gaps in the extant literature, based on which the section proposes the research question. Section 2.5 summarizes the chapter.

2.2 Description of merger arbitrage strategy

After a takeover bid is announced, the target stock is usually different from the price offered by the bidder or the offer price. The difference is termed the 'arbitrage spread'. When the target stock price is smaller (greater) than the offer price, a positive (negative) spread is observed. The spread exists for two reasons. First, the spread reflects the time value of money as the bid usually takes a few months to complete (Weston et al., 2004, ch21). When the time value of money is the primary concern, the target stock trades at a small discount relative to the offer price and the spread is positive. Second, the spread manifests the inherent uncertainty regarding the final terms and outcome of the bid. A positive spread reflects the possibility that the bid may not be consummated with the original offer price or may be revised downward. In case of a negative spread, the market expects that a higher offer from the original bidder or a rival bidder is imminent.

Merger arbitrage, or risk arbitrage, is the investment strategy designed to profits from the uncertainty about the final terms and outcome of a takeover bid. The strategy is structured in the way that the arbitrageurs can lock in the arbitrage spread if the bid is completed. The particular trading tactics employed by the arbitrageurs depend on the form of payment offered to the target shareholders. Cash and stock are two primary forms of payment in a takeover bid. In a cash bid, the bidder offers cash to the target shareholders in exchange for the target stocks. In a stock bid, the target shareholders receive a number of the bidder's stocks for each target stock. To set up an arbitrage investment in a cash bid, the arbitrageurs simply buy the target stocks and sell them to the bidder for the final offer price when the bid is consummated. The investment in a stock bid involves buying the target stocks and at the same time shorting the bidder stocks. At the bid completion date, the arbitrageurs exchange the target stocks for the bidder stocks to cover the short position[1].

The structure of the arbitrage position in both cash and stock bids warrants that, as long as the bid is successful, the arbitrageurs can make a minimum profit equivalent to the arbitrage spread. It is obvious that, when the spread is negative, the arbitrageurs bet not only on whether the bid can go through but also on whether the bid will be revised upward by the original bidder or by a rival bidder. In case of a negative spread, the arbitrage position is more risky because even if the bid is completed but the offer price is not revised upward, the arbitrageurs will surely make a loss that is equal to the negative spread.

There are two fundamental aspects about the strategy. The first aspect refers to the information set utilized by the arbitrageurs. The merger arbitrage position is set up only after the merger or the bid is officially announced. In other words, the arbitrageurs utilize only publicly available information about the bid. Hetherington (1983) insists that merger arbitrage is not an insider game. Och and Pulvino (2005) state that the arbitrageurs never make investment based on rumours; they only invest when the

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[1] In some stock bids that contain option-like terms i.e. collar deals, since the exchange ratio depends on the levels of the bidder stock price and the target stock price at a pricing period near the bid completion date, the merger arbitrage trading tactics in these bids involves dynamic hedging. Please see Fuller (2003) and Officer (2004) for the full description of collars and Mitchell et al. (2004) for the discussion of the arbitrage trading tactics in bids with collars.

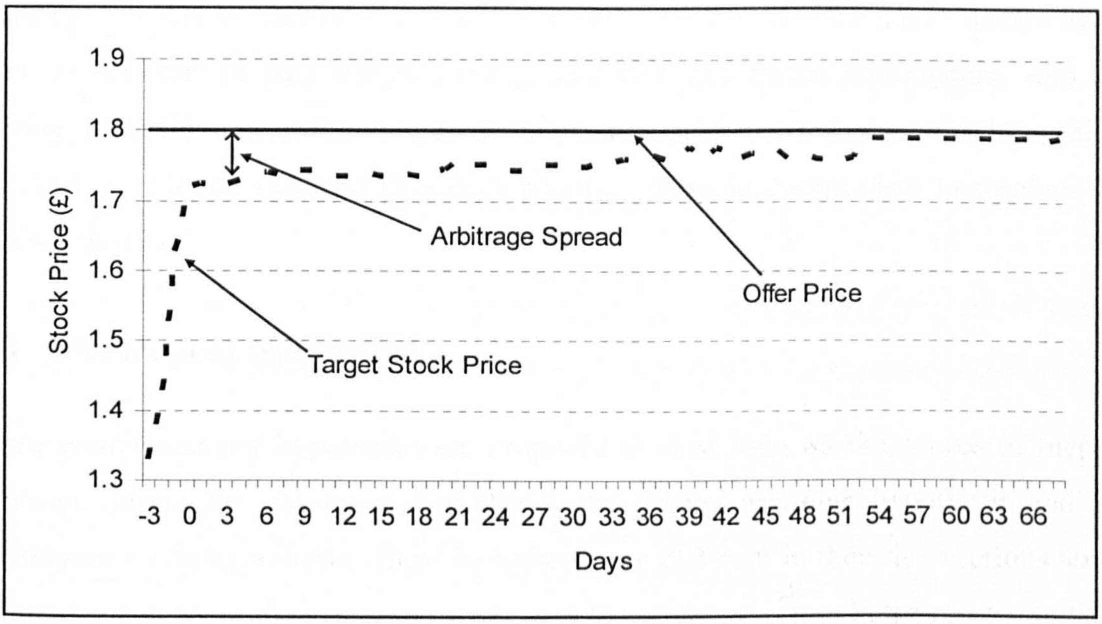
definitive agreement about the merger or a tender offer is announced. According to Moore (1999) and Moore et al. (2006), the arbitrageurs do not bet on whether the bid occurs, instead they speculate on whether the bid will be consummated within an expected period of time.

The second aspect is about the risk in the strategy. Merger arbitrage is a risky investment strategy because there is uncertainty about the final terms and outcome of the bid. In case the bid is completed at the original or a higher offer price, the arbitrageurs can make a handsome profit. If the bid is prolonged or revised downward, the arbitrageurs get smaller return or may suffer a loss. The worst scenario for the arbitrageurs is when the bid is called off. In such cases, as the target stock price may fall all the way back to level of 30-40 days[2] prior to the announcement date when no information about the bid is factored into the price, the losses are usually much larger than the gains. Since substantial losses usually happen when the bid fails to complete, the risk in the merger arbitrage strategy is often termed 'deal completion risk'. Given the fact that the probability of bid failure is only around 15% (Baker and Savasoglu, 2002; Branch and Yang, 2003), in most cases the arbitrageur can earn positive returns, the incidence of failed bid is rare but can result in disastrous losses.

Figure 2.1 depicts the stock price movement of the target in two cash mergers. In Panel A of Figure 2.1, Preussag AG completed the acquisition of Thomson Travel Group PLC after 68 days. The arbitrage position in the target stock from one day after the bid was announced to the bid consummation date would yield an annualized return of 16.62%. In Panel B, the bid for Enodis PLC by Middleby Corp failed after 67 days. A similar arbitrage position in the target stock in this case would result in a substantial annualized loss of -73.35%.

[2] In Schwert (1996), on average the target stock price starts to increase 41 days prior to the date when the bid is officially announced. Goergen and Renneboog (2004) report empirical evidence on the pre-bid price run-up in the European context. The stock price run-up preceding the announcement date may result from insider trading or leakage of information or bidder's setting up toeholds.

Panel A: Successful Merger - Preussag AG's bid for Thomson Travel Group PLC



Panel B: Failed Merger - Middleby Corp's bid for Enodis PLC

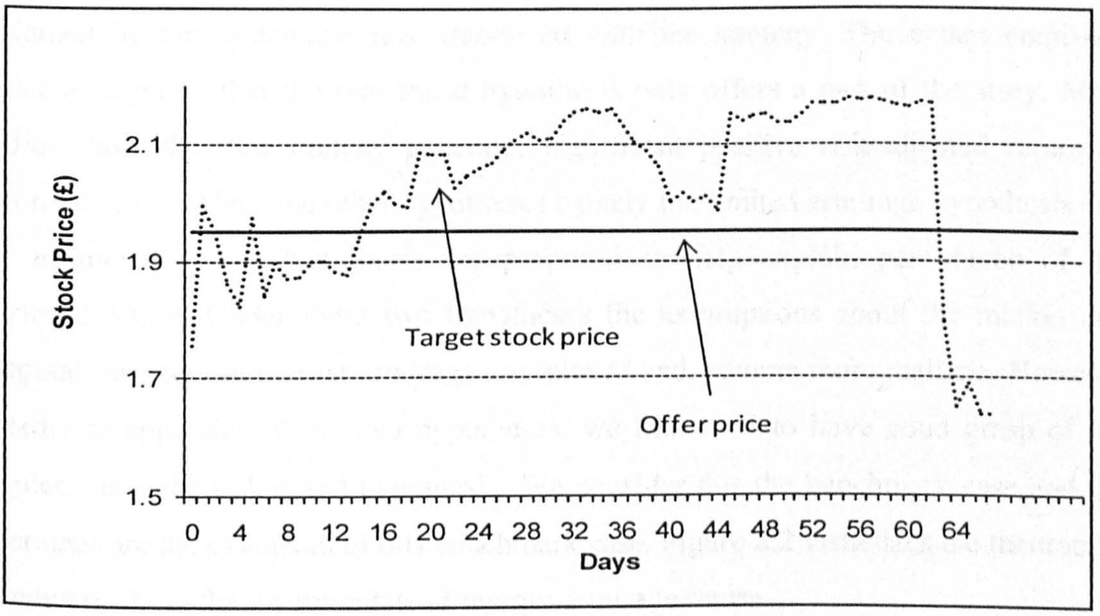


Figure 2.1: Merger arbitrage example

This figure plots the movements of target stock price in two cash mergers. Panel A represents a successful merger; Panel B represents a failed merger

Because of the uncertainty about the final terms and outcome of the bid, merger arbitrage can also be viewed as a risk-shifting strategy whereby the target shareholders, who do not want to bear the deal completion risk, sell to the arbitrageurs, who are willing to. In this sense, the merger arbitrageurs provide the insurance service against the deal completion risk and they earn positive return to compensate themselves for bearing the risk.

2.3 Theoretical framework

Three complementary hypotheses are proposed to shed light on the source of merger arbitrage return: the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageur's role hypothesis. These hypotheses are different in their assumptions about the market and about the marginal investors in the arbitrage game. In the most simplistic setting, under the assumption of a perfect capital market, the risk-based hypothesis states that the merger arbitrage return to well-diversified investors should be fully explained by the systematic risk associated with the strategy. The extant empirical evidence suggests that the risk-based hypothesis only offers a part of the story. Most studies show that the strategy generates significant positive risk-adjusted return or abnormal return. Thus, the other hypotheses namely the limited arbitrage hypothesis and the arbitrageurs' role hypothesis are proposed to help explain persistence of the abnormal return. Under these two hypotheses the assumptions about the market and marginal investors in merger arbitrage are relaxed and become more realistic. However in order to appreciate these two hypotheses, we first need to have good grasp of the simpler one – the risk-based hypothesis. We consider this the benchmark case and the other ones are the extension of this benchmark case. Figure 2.2 visualizes the theoretical framework about the determinants of merger arbitrage return.

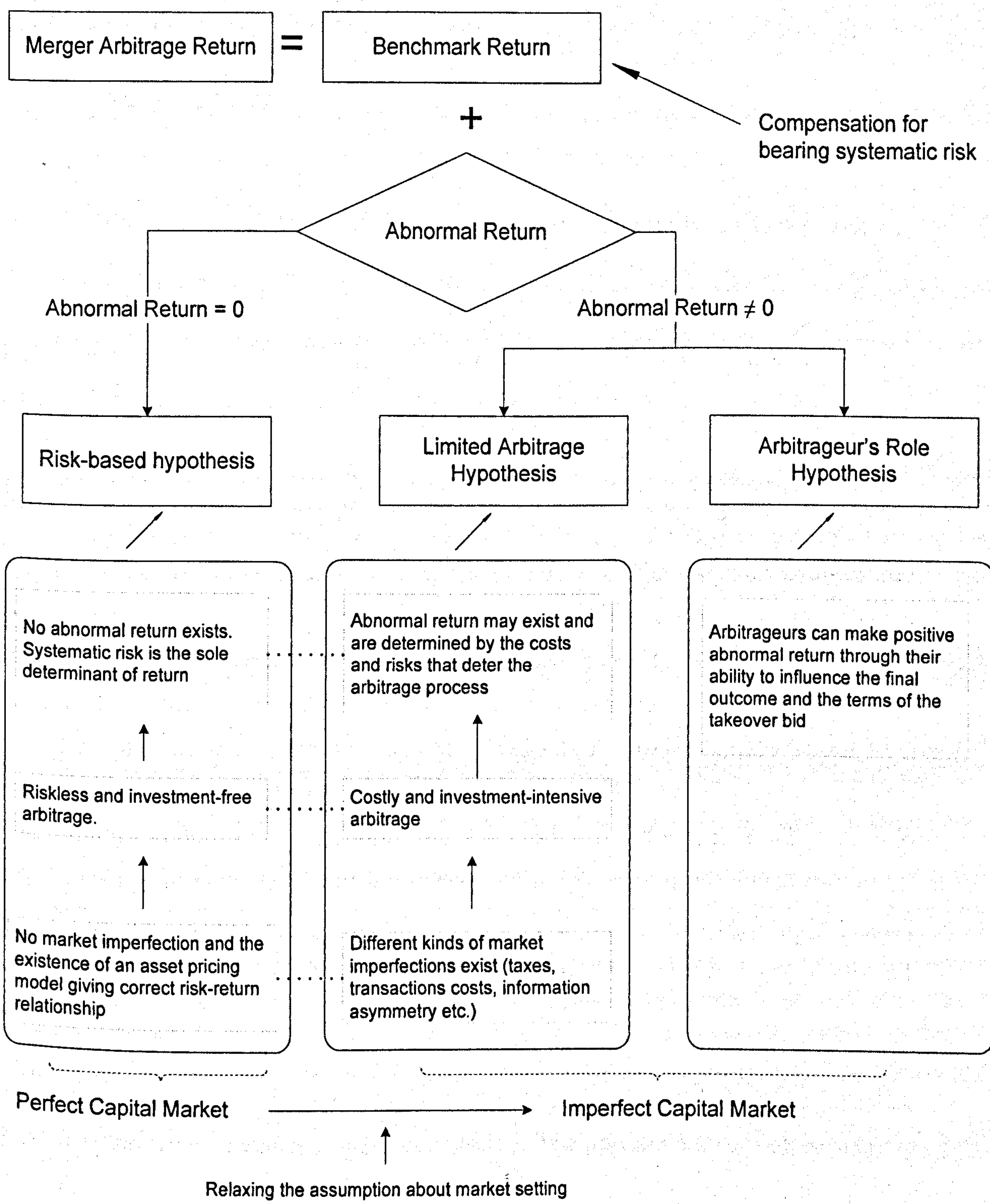


Figure 2.2: The source of merger arbitrage return - theoretical framework

2.3.1 Risk-based hypothesis

Theoretical background

Like the traditional approach of most seminal theories in finance, the starting point of the theoretical framework for the determinants of the merger arbitrage return is based on the standard setting of a perfect capital market characterized by the absence of trading costs, information costs and the restrictions on short-selling. In this setting, the risk-based hypothesis states that the systematic risk associated with the merger arbitrage strategy is the sole determinant of the return to the strategy.

Scholes (1972) argues that financial assets are nothing more than an abstract right to an uncertain future income stream. A rational investor, when investing in an asset, should therefore only care about whether the expected return from the investment sufficiently compensates for the risk stemming from the uncertainty about the asset's future income stream. Thus, in an efficient market where price correctly reflects all available information, assets are priced on the risk-return tradeoff basis. Simply put, two assets with the same risk must offer the same expected return. In the standard setting of a perfect capital market, if the risk-return tradeoff is violated, a risk-less and investment-free arbitrage opportunity will arise. The rational traders in the market will rush in to exploit the opportunity, thereby making the opportunity disappear quickly. This process will warrant that the pricing of any asset follow the risk-return tradeoff. A more detailed discussion about the pricing process of financial assets is provided in Appendix 2.1 (page 52).

The intuition behind the risk-based hypothesis is straight forward. The idea that risk matters comes from the nature of financial assets. The postulation that risk is the only precipitating factor is the consequence of the perfect capital market setting. The discussion in the next section will point out that when market imperfections are introduced, in addition to risk, other factors also contribute to the source of merger arbitrage return.

The empirical test of the risk-based hypothesis requires an asset pricing model that correctly quantifies the risk-return tradeoff. In the perfect capital market setting, it can be shown that the expected return from any investment can be expressed as a linear function of the common risk factors (Ross, 2001, ch1) as following:

$$E[\tilde{R}_i|\Phi_t] = R_f + \beta_i X \tag{1}$$

The left-hand side denotes the expected return of an investment strategy i conditional on the information set Φ_t. R_f is the risk-free rate representing the expected return assuming no uncertainty. X is the vector representing all common risk factors that constitute the source of risk; β_i is the vector representing the sensitivity of the return from the investment strategy to the common risk factors in X. It is important to note that β_i only measure systematic risk of the investment strategy i, which is the part of risk that correlates with the common risk factors in X. Because trading costs are assumed away, the part of risk that is uncorrelated with the common risk factors, idiosyncratic risk, can be costlessly diversified away. Thus, a rational investor should only concern about systematic risk. Proof of the diversification effect can be found in most standard finance textbooks, for instance, Bodie et al. (2005, ch8).

Assuming that we have an accurate risk-return model in the form of equation (1), if merger arbitrage return can be fully explained by the risk-based hypothesis, the realized return from the strategy should tend toward the expected return predicted by that model. Therefore, if we denote $\hat{R}_A$ as the realized returns to the merger arbitrage portfolio and $E[\widetilde{R_A}|\Phi_t]$ as the expected return to the strategy, the quantity $\alpha = \hat{R}_A - E[\widetilde{R_A}|\Phi_t]$ should be zero on average. If we denote the return given by the risk-return model as the normal return, then α measures the risk-adjusted return or abnormal return. The test of the risk-based hypothesis boils down to the test of whether abnormal return is equal to zero on average.

Empirical evidence

Most of the studies on merger arbitrage perform the empirical tests of the risk-based hypothesis. These studies employed two standard risk-return models namely the Capital Asset Pricing Model (CAPM) and the Fama and French (1993) three-factor model (F&F) to estimate the risk-adjusted return or abnormal return to the merger arbitrage strategy. The results are summarized in Table 2.1. Two noticeable features emerge from these studies. First, they unanimously report that the strategy can generate substantial positive risk-adjusted return ranging from 7% in Baker and Savasoglu (2002) to more than 172% in Dukes et al. (1992). The huge variation in the reported return can be attributed to the differences in the way the return to the strategy is calculated[3]. Second, most of the studies are conducted in the US market (7 out of 9). Only two studies employ a non-US sample. On 37 Canadian cash tender offers, Karolyi and Shannon (1999) report merger arbitrage return of 33.90% in excess of the CAPM benchmark for systematic risk. Maheswaran and Yeoh (2005) also find risk-adjusted return of 9.90% - 10.69% on the merger arbitrage portfolio consisting of 193 Australian cash mergers[4].

[Insert Table 2.1, see page 51]

The results in Table 2.1 clearly show that the systematic risk specified in CAPM and F&F model can only explain a part of the return to the merger arbitrage strategy. The implicit assumption underlying these results is that the two models provide an accurate description about the risk-return structure of the merger arbitrage strategy. Thus, the positive abnormal return reported in these studies may not necessarily indicate the failure of the risk-based hypothesis in explaining the source of merger arbitrage return. Instead, the existence of the abnormal return might be the consequence of a misspecified risk-return model. This is the 'bad model' problem pointed out by Fama (1991, 1998).

[3] More detail about the way to calculate the merger arbitrage returns is discussed in section 3.3

[4] All reported returns are annualized returns.

In line with this argument, Mitchell and Pulvino (2001) re-examine the risk-return characteristics of the merger arbitrage strategy. As CAPM and F&F assume linear risk-return relation, the estimated abnormal return using these models might be biased if the true relationship turns out to be non-linear. According to Mitchell and Pulvino (2001), there are good reasons to believe that the return to the merger arbitrage strategy is related to the market risk in a non-linear way. The risk of the strategy comes from the uncertainty about the bid outcome, which depends mainly on the specific characteristics of each individual bid, not on the overall market movement. As a result, the strategy should have very little market risk in most cases. The extant empirical evidence confirms this line of argument. Most studies find that the loading on the market risk factor is close to zero. The non-linear risk-return relation arises because the dynamics in the relation become different during severe market downturn. Since the bidder may have economic incentive to withdraw from the bid when the market is taking a plunge[5], the risk of bid failure increases during market downturn. Thus, the merger arbitrage strategy might have positive market risk when the market is in the declining state, while being market neutral in other market conditions.

With the sample of 4750 US cash and stock bids from 1963 to 1999, Michell and Pulvino (2001) empirically test the non-linear risk-return pattern utilizing a piecewise linear regression model. The authors report evidence supporting the non-linear pattern. Specifically, when the return to the market portfolio adjusted for the risk-free rate (market excess return) is above -4%, the return to the merger arbitrage strategy shows little co-movement with the market return. However, when the market excess return falls below that -4% threshold, the strategy has significant positive market risk. Because of the non-linear risk-return relation, the size and the significance of the abnormal return reported in most studies that employ linear asset pricing models may change when risk is more properly accounted for. In this spirit, Mitchell and Pulvino (2001) apply the contingent-claim approach developed by Glosten and Jagannathan (1994) to control for the non-linear risk profile of the merger arbitrage portfolio. The result is nevertheless

[5] Full discussion about the bidder's economic incentives to abandon the takeover bid during severe market downturn is provided in more detail in Chapter 4.

similar to the ones obtained from the linear risk-returns models. The risk-adjusted return or abnormal return of 10.3% under the contingent-claim approach is both positive and statistically significant.

Maheswaran and Yeoh (2005) also investigate the non-linear risk-return pattern for the Australian market but find no supporting evidence. The merger arbitrage portfolio consisting of 193 Australian cash mergers from 1991-2000 is close to market neutral in all market conditions. Thus, the non-linear risk-return pattern appears to be unique to the US market.

The existing evidence consistently demonstrates that the merger arbitrage strategy can produce significant positive return in excess of the compensation for bearing risk. The result is robust to the choice of the markets where the strategy is conducted as well as to a range of methods to control for risk. This suggests that the risk-based hypothesis can only explain one part of the return to the merger arbitrage strategy.

One might take the view that it does not need to do any empirical test to anticipate the failure of the risk-based hypothesis in fully accounting for the source of merger arbitrage return because the hypothesis is grounded upon a very unrealistic setting of a perfect capital market. It is obvious that such a market never exists. However, with respect to the methodological issue in the development of finance theories, criticizing a theory based on the realism of its assumptions is completely irrelevant. As pointed out by Friedman (1953), the validity of a theory must be judged on how well it can stand with empirical evidence not on how realistic the assumptions are because all theories by nature rest on unrealistic assumptions. In the spirit of the famous Modigliani and Miller's (1958) irrelevance proposition, there is nothing wrong with the standard setting of a perfect capital market as long as the analytical framework built upon the setting is able to explain the real world. Furthermore, by introducing market imperfections to the setting, we can easily extend the framework to identify the precipitating factors.

Following such logic, there are two directions to proceed from the risk-based hypothesis. The first direction is to improve the empirical test of the hypothesis while maintaining the standard setting of a perfect capital market. As the test of the hypothesis hinges upon the validity of the risk-return model itself as well as the econometric procedure to estimate the model, more rigorous tests of the hypothesis can be performed. The second direction relaxes the assumption about the perfect capital market in order to develop new hypotheses to explain why the positive abnormal return exists. In the next sections, we will discuss the other two hypotheses that are developed from the second direction.

2.3.2 Limited arbitrage hypothesis

In the perfect capital market setting, it has been argued in the previous section that when asset price correctly reflects all available information, the systematic risk associated with the merger arbitrage strategy is the sole determinant of the return to the strategy. The empirical evidence nevertheless shows that systematic risk can only be a part of the story. The fact that the strategy persistently produces significant positive return in excess of the systematic risk benchmark is puzzling. The existence of the excess return or abnormal return is equivalent to the existence of 'free money' left on the table. In a competitive market, the competition among arbitrageurs should drive away such 'free money'.

The limited arbitrage hypothesis attempts to resolve the puzzle by relaxing the perfect capital market assumption. Due to market imperfections, the real-world arbitrageurs face different types of costs, risks and constraints[6] other than systematic risk. These costs, risks and constraints constitute the source of the abnormal return to the strategy. The limited arbitrage hypothesis can be deemed as an extension of the risk-based hypothesis when the perfect capital market setting is no longer assumed. Combined with the systematic risk specified under the risk-based hypothesis, the additional costs and risks identified under the limited arbitrage hypothesis provide a much richer description about the source of the return to the merger arbitrage strategy.

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[6] Discussion about different types of risks and costs associated with arbitrage is provided by Tuckman and Vila (1992), Pontiff (2006), Figlewski (1979), Campbell and Kyle (1993), De Long, et al. (1990) Shleifer and Vishny (1997), and Abreu and Brunnermeier (2002)

There are two competing theories about the source of the abnormal return under the limited arbitrage hypothesis, that is, the arbitrage cost theory and the price pressure theory. Under the former, the abnormal return exists due to the additional costs and risks (other than systematic risk) that prevent the arbitrageurs from coming into game to compete away the abnormal profits. Under the latter, the abnormal return exists as a consequence of the fact that the target stock price falls below its efficient level because of a selling pressure. In the following paragraphs, we discuss each theory in more detail.

The arbitrage cost theory focuses on the costs and risks that arbitrageurs have to incur in establishing the arbitrage positions. If these costs are even bigger than the expected abnormal profits, it is rational for arbitrageurs not to come into the game. In this case, there is no 'free money' to be picked up. The arbitrageurs earn fair return commensurate with the risks and costs associated with the strategy.

According to Pontiff (2006), there are two types of arbitrage costs that the arbitrageurs typically have to face: transaction costs and holding costs. Transaction costs arise from the arbitrageurs' establishing and closing their positions. These are one-off costs and do not depend on the duration of the arbitrage positions. Examples of transaction costs include brokerage fees, commissions, transaction taxes, price impact of trades and information costs. Holding costs are the costs per unit of time. Arbitrageurs are subject to holding costs as long as the arbitrage positions remain open. The most obvious holding cost is the opportunity cost of tying up capital in the arbitrage positions. Almost all empirical studies on merger arbitrage control for this cost by subtracting the risk-free return from the return to strategy. Other holding costs are due to short-sale constraints and idiosyncratic risk, which will be articulated later.

The implicit assumption in the arbitrage cost theory is that the arbitrageurs have access to unlimited supply of capital. 'Smart money' from the professional arbitrageurs stands ready to flow into the game to pick up any abnormal return. Thus, after all the costs and risks associated with setting up the arbitrage positions are taken into account, the merger arbitrageurs are left with zero extra profits. Thanks to the abundance of arbitrage capital, the arbitrageurs on average should earn a fair return and the pricing of merger stocks is efficient.

Under the price pressure theory, it is argued, nevertheless, that the assumption of unlimited capital might be untenable. Shleifer and Vishny (1997) developed a theoretical model showing that due to the agency relationship between the arbitrageurs and the investors, who provide capital to the arbitrageurs, the arbitrageurs in the real world may face capital constraints. The consequence of the world with capital-constrained arbitrageurs is that the pricing of merger stock is subject to a selling pressure, which in turn leads to the inefficient pricing. As a result, the excess return in the merger arbitrage game is real and remains on the table because the arbitrageurs do not have enough capital to drive it away. Next, we discuss the conceptual basis and the empirical evidence for these two theories.

A. Arbitrage cost theory

Transaction costs

In the context of merger arbitrage, the arbitrageurs incur trading costs and information costs. In cash bids, as the arbitrageurs only hold a long position in the target stock, they incur the costs of trading in the target stocks. In stock bids, as the arbitrageurs simultaneously hold a long position in target stocks and a short position in bidder stocks, they face the costs of trading in both the target and the bidder stocks. In both cash and stock bids, the arbitrageurs also need to gather and analyze information about the outcome of the takeover bid, hence incur information costs.

Trading costs

There are two types of trading costs:

- Direct trading costs are those that the arbitrageur pays to the financial intermediaries to execute the trade. The direct costs include brokerage fees, bid-ask spreads, transaction taxes and other types of surcharges;
- Indirect trading costs refer to the costs associated with adverse price movements when trading large quantity of stocks. For example, suppose the target stock is trading at £10 per share, if the arbitrageur buys a small quantity of target stock, say,

100 shares, his trade does not affect the price, which means that he can still buy the stock at £10 per share. The story is different if the arbitrageur buys a large quantity of target stock, say, 1 million shares. In this case, the trading of the arbitrageur results in a surge in the demand for the stock that may increase the stock price, for instance, to £11. In this case, because of his own trading, the arbitrageur has to buy the target stock at £1 higher than the original price. The amount £1 reflects the indirect trading costs. This type of indirect costs is termed as price impact costs[7] in the market microstructure literature and is estimated using intraday high frequency data. The price impact of trade can be used as a measure of the stock' liquidity. The less liquid a stock is, the higher is the price impact.

With a sample of 4750 US cash and stock bids from 1963 to 1999, Mitchell and Pulvino (2001) examine the impact of trading costs on merger arbitrage abnormal return. In addition to the direct and indirect trading costs, the authors also consider the practical limitations that the real-world arbitrageurs place on the formation of the merger arbitrage portfolio. The first limitation is that the amount invested in each arbitrage position does not exceed 10% of the portfolio value. The second limitation is that the arbitrage position consisting of illiquid stocks that have more than 5% price impact are excluded from the portfolio. The empirical result shows that when trading costs and practical limitations are considered, the abnormal return drops significantly from 9.25% to around 3.54% per annum. The authors conclude that trading costs and practical limitations account for a large part of the abnormal return; the remaining return is still nonetheless both statistically and economically significant.

Maheswaran and Yeoh (2005) examine the impact of trading costs on the return to the merger arbitrage portfolio comprised of 193 Australian cash mergers from 1991 to 2000. The study reports that the abnormal return based on the Fama and French (1993) three-factor model is close to zero after trading costs are taken into account. Thus, in the Australian context the trading costs appear to account entirely for the abnormal return to the merger arbitrage strategy.

[7] For more discussion about price impact of trades, please see Chen et al. (2005), and Lesmond et al. (2004)

Information costs

To assess the risk that a takeover bid might not consummate, the arbitrageurs often need the expert knowledge and information in different fields ranging from finance, accounting, and strategy to legal and regulatory issues[8]. Thus, it is likely that the arbitrageurs face information costs in evaluating the potential outcome of a single bid. While the data for trading costs are available, it is not the case for information costs. Typically, the amount of money each arbitrageur spends on gathering and analyzing information about the outcome of a takeover bid is unknown to the outside world. As a consequence, the empirical studies regarding the impact of information costs on the abnormal return to the merger arbitrage strategy employs a different research design compared to those studies regarding the impact of trading costs. As for the latter studies, the costs of trading are estimated and then offset directly against the abnormal return to the strategy. Since the data about information costs are generally unavailable, it is difficult to assess the impact of information costs using this approach. Instead, the studies on information costs use a two-step research design. In the first step, the researchers assume that the arbitrageurs must have incurred substantial information costs. Based on that assumption, the researchers establish the empirical implications. Testing such empirical implications is the second step.

If the merger arbitrageurs do indeed spend considerable resources on acquiring information about the bid outcome, they may be regarded as better informed than other investors in the market. There are two studies that report supporting evidence for this implication. First, on the sample of 111 US cash tender offers from 1977 to 1983, Larcker and Lys (1987) find that the success rates of the offers in which arbitrageurs invest are significantly higher than the expected probability of success implied in the market prices. They postulate that the arbitrageurs must have engaged in costly information acquisitions enabling them to obtain superior knowledge about the outcome of the takeover bid. Second, Hsieh and Walkling (2005) report a positive relationship between the presence of the arbitrageurs and arbitrage returns, the probability of bid

[8] Please see Moore (1999; 2006), Paulson (2003) and Wyser-Pratte (2009) for more insights into the decision making process of professional merger arbitrageurs.

success and the probability of bid revision after other publicly available information is controlled for. This indicates that arbitrageurs seem to be in a better position than the average investors in the market to assess the outcome of a takeover bid, thereby being able to earn higher return.

Holding Costs

Idiosyncratic risk

In our discussion in section 2.3.1 about the risk-based hypothesis, we mention that idiosyncratic risk should not matter if arbitrageurs can eliminate it by holding a diversified portfolio. Shleifer and Vishny (1997), however, argue that the real-world arbitrageurs may not get access to a diversified portfolio of arbitrage opportunities. Thus, under-diversified arbitrageurs are also concerned about idiosyncratic risk. Merton (1987) develops an information-based asset pricing model showing that idiosyncratic risk should be priced when investors do not hold diversified portfolios. Treynor and Black (1973) go a step further to show that an active portfolio manager or a sophisticated investor is subject to idiosyncratic risk regardless of his level of diversification. Pontiff (2006) points to idiosyncratic risk as the most important holding costs that arbitrageurs have to face.

On the empirical side, it has been reported that idiosyncratic risk plays a significant part in explaining the cross-section variation of equity returns. Fu (2009) applies the exponential GARCH models to estimate the stock idiosyncratic volatility and finds significant positive relationship between this measure of idiosyncratic risk and expected returns. In reviewing the literature about costly arbitrage, Pontiff (2006) reports that idiosyncratic risk helps explain a range of anomalous events in financial markets. For example, idiosyncratic risk is considered in Pontiff (1996) to shed light on the closed-end fund discount puzzle, in Ali et al. (2003) to explain the book-to-market anomaly, and in Mashruwala et al. (2006) to explain the accrual anomaly. More recently, Li et al. (2009) identify idiosyncratic risk as one of the causes of the value premium phenomenon, in which value stocks tend to outperform growth stock. Au et al. (2009) and Duan et al. (2009) find that the level of short interest is inversely related to the magnitude of idiosyncratic risk. This indicates that idiosyncratic risk deters sophisticated investors from short selling the stock for hedging or for betting on a possible mispricing.

In the context of merger arbitrage, idiosyncratic risk may be one of the reasons why arbitrageurs do not come into the game to compete away the abnormal profits. Baker and Savasoglu (2002) test the importance of idiosyncratic risk in explaining the cross-sectional variation of the abnormal return to the merger arbitrage strategy. They find a significant positive relationship between the strategy's abnormal return and two positive proxies for the strategy's idiosyncratic risk: the variance of the estimated probability of bid success and bid premium. The first component, the variance of the estimated probability of bid success, measures the degree of uncertainty regarding the outcome of a takeover bid. The higher is the variance, the more difficult it is to accurately quantify the chance that the bid can go through. The second component, bid premium, represents the expected amount of losses that the arbitrageur might incur in the event the takeover bid fails to consummate. The empirical evidence reported by Baker and Savasoglu (2002) shows that the arbitrageurs' exposure to idiosyncratic risk is significantly related to the arbitrage excess return. This result is also consistent with other studies about the role of idiosyncratic risk as one of the important determinants of asset returns.

Short-sale Constraints

Short-sale is defined as the act of selling a security which is not owned by the seller. To sell short, the seller needs to borrow the security from the market for securities loan. Short-sale constraints refer to the frictions and restrictions on the securities loan market faced by the borrower i.e. the short-seller. As will be discussed in more detail later, short-sale constraints impose on the short-seller as long as the short position remains open. Thus, short-sale constraints are categorized as one type of holding costs.

In merger arbitrage, while the investment in a cash bid only requires the arbitrageurs to buy the target stock, in a stock bid, the arbitrageur needs to simultaneously buy the target stock and short sell the acquirer stock. As a result, the arbitrageur faces short-sale constraints only when investing in stock bids.

Short-sale constraints manifest in four ways. First, the arbitrageur does not have access to the proceeds from selling the stock he borrows, and, therefore, arbitrage always requires investment. Second, not all stocks are available to borrow for short selling. Third, to borrow a stock the arbitrageur has to pay a fee to the lender. Although such a fee is generally low, it can be unexpectedly high when the demand to borrow the stock greatly exceeds the supply. Under such circumstances, the stock is said to become special. Fourth, short sellers face the risk that the stock can be recalled anytime by the lenders.[9]

With one year equity loans data provided by a major lender, Geczy et al. (2002) investigate the impact of short-sale constraints on the return to the merger arbitrage portfolio including 226 US stock bids from 1998 to 1999. The study reports that short-sale constraints can significantly impair the profitability of merger arbitrage strategy. The impact of short-sale constraints is not through the cost of short selling but through the shortage of the stocks available for loans. Specifically, the portfolio constructed on the assumption of no short-sale constraints earns annualized raw return of 64%. When the portfolio is constructed on only the bids, in which the acquirer stocks are available to short, the return declines significantly to 45%. Assuming that the stocks that become special cannot be borrowed, the return drops to 31%. The cost of short selling, i.e. the fee paid to the lender, only reduces the return by 0.26%. The study concludes that although short-sale constraints significantly reduce the merger arbitrage returns, the remaining return are still substantial. Furthermore, as the arbitrageur only faces short-sale constraints when investing in stock bids, short-sale constraints cannot explain the arbitrage return in cash bids.

The extant empirical evidence points to a range of risks and costs that deter the arbitrageurs from entering the merger arbitrage game to compete away the abnormal profits. All the costs and risks to arbitrageurs combined may help explain why the return to the merger arbitrage strategy deviates significantly away from the level that represents the compensation for systematic risk. If this is true, then there is no

[9] For a detailed discussion about the institutional features of the market for securities loan, see Thomas (2006), D'Avolio (2002), Duffie et al. (2002), and Au et al. (2009)

inefficiency in the pricing of merger stocks as no 'free lunch' is available. In the next section, a different view is discussed.

B. Price Pressure Theory

Under the arbitrage cost theory, there is nothing 'abnormal' in the excess return to the merger arbitrage strategy. The excess return compensates arbitrageurs for bearing the additional costs and risks other than the systematic risk. If the arbitrage cost theory holds, there would be no inefficiency in the pricing of the merger stocks. The arbitrageurs earn fair return commensurate with different types of risks and costs. The price pressure theory, by contrast, argues that the excess return to the strategy is indeed 'abnormal'. Under the price pressure theory, the target stock price may be subject to a selling pressure and as a consequent, may fall below the efficient level leaving a chance for arbitrageurs to earn abnormal profits. Thus, according to this theory, the abnormal return results from the inefficiency in the pricing of the merger stocks.

The theoretical foundation of the price pressure theory is the agency-based model of limited arbitrage developed by Shleifer and Vishny (1997). The model focuses on the agency relationship between the investors (the principal), and the arbitrageurs (the agent), who combine their knowledge with the capital from the principal. As the arbitrage game requires special type of knowledge and information, within each segment which can be interpreted as a particular arbitrage strategy, arbitrage is usually conducted by only a few highly skilled arbitrageurs. These specialized arbitrageurs are subject to capital constraint in two ways.

First, since different investors hold different judgements about the profitability of various arbitrage strategies, each strategy or each segment does not end up with all the capital but a limited amount of capital. In other words, arbitrageurs specializing in a particular segment are often capital-constrained.

Second, and more subtle, the fear of losing capital when things go wrong makes an arbitrageur voluntarily limit the amount of capital he is willing to put in each trade. As argued earlier, because arbitrage trading is highly specialized and obscure, it is almost impossible for the outside investors to understand the ins and outs of every arbitrage trade. As a consequence, the outside investors make their decision about whether to supply the arbitrageurs with capital based on the arbitrageurs' past performance. If an arbitrageur placed a substantial amount of capital on a single bet and the bet goes wrong, it may be very difficult for him to raise additional capital in the future. Even though the bet is grounded upon very sound economic rationale in the first place, because of the opaque nature of the arbitrage trade, it is very difficult for the outside investors to judge whether the wrong bet is due to arbitrageur' incompetence or just bad luck. The principals face a moral hazard problem and may decide not to supply any additional capital to the arbitrageur. Even worse, they may start withdrawing their current investment. The fear of losing capital under management limits the amount of capital the arbitrageur is willing to bet on each trade.

In the context of merger arbitrage, the fact that arbitrageurs are capital-constrained can have direct consequence on the pricing of merger stocks. After the bid is announced, the target shareholders, who do not want to bear the deal completion risk, start selling their shares in the target firm, thereby creating a selling pressure. When the arbitrageurs are capital constrained, the arbitrage community might not be able absorb the selling pressure. Consequently, the target stock may fall well below its efficient price enabling the arbitrageurs who are able to soak up this excess supply to earn substantial abnormal returns. The price pressure theory would predict that the larger is the selling pressure, the higher the excess return to the strategy.

Baker and Savasoglu (2002) test the price pressure theory. The authors argue that the bigger is the target size, the higher the number of target shares are sold by the target shareholders. Thus, target size can be a positive proxy for the selling pressure. If the price pressure theory is valid, the excess return should be positively related to target size. Interestingly, target size can also be a proxy for transaction costs. The cost of trading in the stocks of big firms tends to be smaller than in those of small firms since big stocks are usually more liquid and information about big stocks is more transparent (Ali et al., 2003; Pontiff, 1996). Because target size is inversely related to transaction costs, if transaction costs are true driving force behind the excess return to the strategy, then a negative relationship between the arbitrage excess return and target size should be observed.

It is clear that the price pressure theory and arbitrage cost theory postulate opposite relationship between the arbitrage excess return and target size. For a sample of 1901 US cash and stock bids from 1981 to 1996, Baker and Savasoglu (2002) find supporting evidence for the price pressure theory. The excess return to the merger arbitrage strategy is increasing in the selling pressure proxied by target size. This evidence also indicates that the price pressure effect dominates the transaction cost effect.

Since the root cause of the price pressure effect is that the arbitrageurs are capital constrained, a direct test of the price pressure theory should be about the relation between the excess return to the strategy and the arbitrageurs' capital. However, Baker and Savasoglu (2002) find that the relation between the arbitrageurs' capital and the arbitrage abnormal return is not statistically significant. The authors attribute this weak association to the noisy measure of arbitrageur's capital since the data is only available for equity capital. In reality, arbitrageurs can extensively use leverage. This result casts some doubt on the validity of the price pressure theory.

Officer (2007) re-examine the Shleifer and Vishny's (1997) agency-based model of limited arbitrage in the context of merger and acquisition by analyzing the responses of arbitrage spread and arbitrage return to the occurrences of arbitrage disasters defined as the event when the merger arbitrageurs suffer huge losses. If the constraint on arbitrageurs' capital has real impact on the pricing of merger stock, such impact should be most evident following arbitrage disasters. The arbitrage disasters would significantly reduce the supply of capital to arbitrageurs for two reasons. First, arbitrageurs lose capital due to the losses themselves. The reduction in capital is particularly serious if the arbitrageurs do not diversify their portfolios across bids. In that scenario, a significant proportion of the arbitrage portfolio may be exposed to the disastrous events. Second, outside investors may think that the huge losses result from the arbitrageur's incompetence. As a result, they will limit the amount of capital available to the arbitrageurs by not supplying more funds or even withdrawing part of their funds.

The reduction in the supply of capital from the outside investors may force the arbitrageurs to liquidate their positions in the pending merger bids or make the arbitrageurs more cautious with their investment in future merger bids. Thus, if capital available to arbitrageur is reduced following disastrous events as predicted by the agency-based limited arbitrage model, wider spreads, hence higher arbitrage returns, for the pending bids surrounding the disastrous events and for the bids announced shortly after the events should be observed.

Analyzing the changes in arbitrage spreads and arbitrage returns of 15 arbitrage disasters from 1985 to 2004, Officer (2007) finds very little supporting evidence for the agency-based limited arbitrage model. There is no statistically significant difference between the pre- and post- arbitrage disaster spreads of the pending merger bids. Also arbitrage disasters have no impact on the arbitrage return in the pending bids and in the bids announced shortly after the disaster events. The author reports no change in the target share turnovers in the pending bids following the disaster events. This shows that the trading behaviours of the merger arbitrageurs are hardly affected by the disaster events.

The empirical result reported by Officer (2007) shows little support for the agency-based model of limited arbitrage. It seems that the merger arbitrageurs do not face capital constraint at all. Thus, Officer's (2007) finding indicates that the weak association between the arbitrage abnormal return and the arbitrageurs' capital found in Baker and Savasoglu (2002) may not come from a noisy measure of the arbitrageurs' capital but simply because the price pressure effect may be of second order importance in the merger context.

To sum up, the arbitrage cost theory stipulates that the excess return to the strategy compensate the arbitrageurs for bearing additional risks and costs other than systematic risk. The existing empirical evidence points to trading cost, information cost, idiosyncratic risk and short sale constraints as the possible drivers of the abnormal return to the strategy. When these risks and costs are properly controlled for, the abnormal return should disappear and there would be no inefficiency in the pricing of merger stocks. The price pressure theory, by contrast, proposes that the abnormal return results from inefficiency in the pricing of merger stocks. As the real-world arbitrageurs might be capital constrained, the target stock price is subject to a selling pressure and falls below its efficient level. The empirical evidence about the price pressure theory is, nevertheless, largely inconclusive.

2.3.3 Arbitrageurs' role hypothesis

In the limited arbitrage hypothesis, the abnormal return exists because the real-world arbitrageurs face various risks, costs, and constraints other than systematic risk. The arbitrageur's role hypothesis proposes another plausible explanation for the persistence of the arbitrage abnormal return. Under this hypothesis, the existence of the arbitrage abnormal return is linked to different roles that the arbitrageurs play in the takeover process. According to Hsieh and Walkling (2005), the arbitrageurs can play 3 roles: a naive investor, a passive investor and an active investor. We discuss each role in detail.

First, as naive investors, the arbitrageurs act like the average investors in market. This means that the arbitrageurs simply invest in a random portfolio of takeover bids and hope for the best. Since the arbitrageurs are often professional investors, who manage capital on behalf of clients (Shleifer and Vishny, 1997), the possibility that they are naive investors seems to be far-fetched. Interestingly, the majority of empirical studies on merger arbitrage implicitly assume this possibility. In many studies, the way that takeover bids are selected for the arbitrage portfolio is mainly based on the availability of data. Obviously, such a portfolio is accessible to all investors in the market. When the 'naive arbitrageurs' earn abnormal return, any investor in the market is able to emulate. If this is true, two possibilities exist. First, the abnormal return represents the compensation for additional costs and risks other than systematic risk that the arbitrageurs have to face. Second, the abnormal return reflects the inefficiency in the pricing of merger stock. These possibilities are discussed in the limited arbitrage hypothesis, Section 2.3.2

As passive investors, the arbitrageurs do better than investing in a random portfolio of takeover bids. Through either information acquisition or internal research, the arbitrageurs obtain superior knowledge about the final outcome of the takeover bid.

Hence, they have the ability to select the best bids for their portfolio and are able to earn higher risk-adjusted return than the average investors. The passive role of arbitrageurs is first suggested by Larcker and Lys (1987), who find that the actual success rates of the takeover bids that the arbitrageurs invest in are significantly higher than the probability of success implied in the market price[10]. It is noted that the arbitrageurs are passive in the sense that they do not actively leverage their stakes in the target to alter the outcome of the takeover bid. This is to differentiate between the passive arbitrageurs with the active arbitrageurs discussed later. For the passive arbitrageurs, their ability to earn abnormal return comes from the superior knowledge about the outcome of the bid.

As above-mentioned, the major difference between a passive arbitrageur and an active one is that the latter does not just 'sit on' their stakes in the target but actively leverage the stakes to influence the outcome of the bid. In other words, the arbitrageurs do not passively watch and analyze the merger process but become part of the process. The possibility that the arbitrageurs are active investors is particularly interesting. In the conventional sense, the arbitrageurs simply take a bet on whether the bid can go through. They win the bet if the bid is consummated and lose if the bid fails. The odd that they can win the bet is determined by various factors[11] that are typically outside their control. When the arbitrageurs are passive, they can make abnormal profits if they can guess the odd better than other investors in the market. When the arbitrageurs are active, they can influence the odd that they are betting on. This is a version of self-fulfilling prophecy, which makes the study about the active role of arbitrageurs a fascinating field. The active arbitrageurs derive their abnormal return through their ability to influence the outcome of the takeover bids.

Two theoretical models are devoted to explore the behaviours of these active investors and how these investors can influence the bid outcome. These models are developed by Cornelli and Li (2002) and Gomes (2001). In Cornelli and Li's (2002) model, the arbitrageurs help to solve the free-rider problem in a takeover contest, thereby facilitating the takeover. In Gomes' (2001) model, the arbitrageurs can exert influence

[10] We will discuss the result of Larcker and Lys's (1987) study in detail later in this section
[11] These factors are discussed in section 3.4

on the bid because they can hold out the bid until the bidder offers good terms. We discuss each model in detail.

Cornelli and Li's (2002) model

The presence of arbitrageurs in the takeover contest provides a solution to the classic free-rider problem propounded by Grossman and Hart (1980). To illustrate Cornelli and Li's (2002) model, we first discuss the free-rider problem.

In a value-enhancing takeover, the bidder perceives the equity value of the target as $V + r$, where V is the equity value of the target firm under the incumbent management and r is the additional value that bidder can obtain if it can control the target firm. To make a profit, the bidder will make an offer of $V + \pi$ to the target's shareholders, where π is the bid premium and π is strictly less than r. Consider an individual shareholder, who holds a fraction α of the target's equity shares. Let call him *D*. He decides whether or not to tender based on the payoffs from his decision. Let's look at *D*'s payoff matrix.

	Bid succeeds	Bid fails
Tender	$\alpha(V + \pi)$	αV
Not tender	$\alpha(V + r)$	αV

If we de note λ_1 and λ_2 as the probability that the bid would succeed in case *D* chooses to tender and chooses not to tender respectively, the expected payoff from each decision is:

When he chooses to tender:

$$\lambda_1\alpha(V + \pi) + (1 - \lambda_1)\alpha V = \alpha(V + \lambda_1\pi) \quad (2)$$

When he chooses not to tender:

$$\lambda_2\alpha(V + r) + (1 - \lambda_2)\alpha V = \alpha(V + \lambda_2 r) \tag{3}$$

D decides to tender only if the payoff in (2), the case he tenders, is larger than the payoff in (3), the case he does not tender. Mathematically, the condition for *D* to tender is:

$$\lambda_1\pi > \lambda_2 r \tag{4}$$

When *D* is a small shareholder, i.e. α is very small, his tendering decision has very little impact on the probability that bid will go through. In other words, for a small shareholder, the probability of bid success in case he chooses to tender is approximately equal to the probability of success in case he chooses not to ($\lambda_1 \approx \lambda_2$). In this case, (4) is equivalent to:

$$\pi > r \tag{5}$$

This condition cannot be met because the bidder only offers bid premium π that is strictly smaller than the additional value r that he can bring to the target firm. Thus, when *D* is a small shareholder, his optimal choice is not to tender. Intuitively, since *D* knows that his tendering decision has no impact on the bid outcome, he would be better off if he chooses not to tender. By delaying his tendering decision, in the event that the bid succeeds, *D* can share part of the enhancement value r, instead of receiving part of bid premium π, which is lower. In other words, *D* decides to 'free-ride' on the bidder's effort to enhance the target value. If the majority of the shareholders in the target are small shareholders like *D*, a value-enhancing bid can never succeed as those small shareholders will choose to free-ride. Thus, the bidder faces the free-rider problem in its attempt to acquire the target.

According to Cornelli and Li (2002), the presence of arbitrageurs can help solve the free-rider problem because the arbitrageurs play the role of large shareholders. To elucidate why large shareholders can be a solution to the free-rider problem, we analyze the tendering condition (4). In the event that D instead is a large shareholder, his tendering decision can have significant impact on the probability of bid success. If D chooses to tender, the bid has higher chance of going through. In other words, λ_1 can be substantially greater than λ_2. Thus, bidder can always choose some level of bid premium π less than the enhancement value r so that the tendering condition (4) can be satisfied. In such case, D*'s* optimal choice is to tender his shares. If the large shareholders control the majority of the target shares, the bid will succeed and the bidder can make a positive profit.

Cornelli and Li (2002) argue that thanks to arbitrageurs, even when only small shareholders constitute the target's pre-bid ownership structure, the bid still have the positive chance of success. After the bid announcement, the arbitrageurs can accumulate shares and become the temporary large shareholders. As our analysis shows, the arbitrageurs' optimal choice in this case is to tender their shares, thereby facilitating the takeover. However one question arises naturally from this line of argument. If the pre-bid ownership structure of the target firms already consists of several large shareholders, does the presence of arbitrageurs make any difference?

The answer is 'Yes' on two counts. First, if the number of shares controlled by the large shareholders is less than what needed for the bidder to take over the target, the free-rider problem is still inherent. The arbitrageurs can come in and make up for the shortage. Second, the large shareholders do not always facilitate the takeover process. Gaspar et al. (2005) report empirical evidence that whether the large shareholders favour the takeover bid is conditional on their investment horizon. In particular, short-term investors tend to sell their holdings and walk away, and therefore, speed up the takeover, whereas long-term investors tend to exert their power on the negotiating table and, contingent on the offer terms can deter or facilitate the bid. Thus, the impact of the large share ownerships on bid outcome is indeterminate at best (Sudarsanam, 1995). As far as the arbitrageurs are concerned, owing to the fact that they only come to the takeover game for a quick profit, it is likely that they are short term investors. Arbitrageurs' short-termism enables them to facilitate the takeover bid.

In Cornelli and Li's (2002) model, the arbitrageurs, as the short-term large shareholders in the target firm, help solve the free-rider problem and facilitate the takeover bid. Aware of such role of arbitrageurs, the bidder will increase the bid premium ex ante or revise the bid upward ex post to attract more arbitrageurs into the game. Thus, the model predicts positive relations between the presence of arbitrageurs and bid premium and the probability of bid success.

Gomes's (2001) model:

Gomes (2001) argues that the arbitrageurs' role in the takeover game is not to solve the free-rider problem but to hold-out the bid until the bidder can offer more favourable terms. In his model, the bidder can overcome the free-rider problem via a freezeout mechanism. In particular, the bidder makes an offer conditioned on the receipt of shares representing f percentage of the target equity, where f is the freezeout threshold, above which the bidder can compulsorily acquires the remaining shares at the offer price. Thus, if the bid succeeds, those small shareholders, who choose to free-ride, are frozen-out and forced to convey their shares to the bidder. The value of f varies across jurisdictions. In the UK, under Section 428 to 430F (inclusive) of the Company Act 1985[12], f is equal 90% of the target equity. According to Gomes (2001), more than 90% of the takeover bid offers in the UK and in the US are freezeout-style offers.

To illustrate why the freeze-out offers can solve the free-rider problem, we come back to the shareholder *D*. In the context of a freezeout offer, if the bid succeeds, the remaining shareholders are forced to 'enjoy' the bid premium and, as a result, will tender their shares. The payoff matrix is as followings:

[12] See Kenyon-Slade (2004)

	Bid succeeds	Bid fails
Tender	$\alpha(V+\pi)$	αV
Not tender	$\alpha(V+\pi)$	αV

It is clear that D receives the same payoffs regardless of his tendering decision; hence there is no room for D to free-ride on this freezeout-style bid. As suggested by Shleifer and Vishny (1986), D's best response is to tender his shares because such action will enhance the chance that the bid will go through, even very slightly in case D is a small shareholder. When the bid succeeds, D's wealth increases by the bid premium whereas his wealth remains unchanged if the bid fails. The reason for D to tender is even more compelling if the bidder is allowed to employ coercive bidding tactics[13] in this freezeout-style offer. For instance, the bidder can employ two-tiered offer, in which the minority shareholders, who choose not to tender, will receive a back-end price lower than the front-end offer price. Under such circumstances, the small shareholders will stampede to tender their shares.

Although the freezeout-style offer can solve the free-rider problem, there arises a paradox. Tendering is always a better choice for the target's small shareholders even if the bidder offers a small premium. This runs counter to the large amount of empirical evidence suggesting that the target shareholders on average receive substantial premium (Andrade et al., 2001; Moeller et al., 2004). According to Gomes (2001), the bidder can only succeed with a low premium if the target ownership structure only consists of small shareholders. Due to lack of co-ordination, these small shareholders' optimal choice is to tender even when the premium is not adequate.

[13] The coercive bidding tactics are generally prohibited by the UK City Code. See Comment and Jarrell (1987) for more detail about coercive bidding tactics in the US context. Many antitakeover state laws have over the years made two-tier coercive offers very difficult. See Sudarsanam (2010, ch18 and ch21) for more detail.

The paradox can be resolved with the presence of arbitrageurs as the target's large shareholders. Thanks to their large stakes, one arbitrageur (if he controls sufficient shares) or a group of arbitrageurs can hold out the bid. In the UK market, where the bidder needs to obtain at least of 90% of the target's equity shares to conduct a freezeout merger, the arbitrage community only needs to accumulate 10% of target shares to be able to prevent the bidder from freezing out the remaining shareholders. The bidder, in anticipation of the arbitrageurs' hold-out power, will offer high pre-emptive bid or revise the bid upward to ensure that the arbitrageurs will tender their shares. Thus, Gomes' (2001) model also predicts a positive relationship between the presence of arbitrageurs and bid premium. The relationship between the presence of arbitrageurs and the probability of bid success is not clear in Gomes' (2001) model.

As arbitrageurs can influence the bid outcome merely by playing the role of large shareholders, a similar question, as in the case of Cornelli and Li (2002), arises. If the pre-bid ownership structure of the target firm already includes large shareholders, can arbitrageurs' hold-out power make any difference? Though the answer is 'Yes' in Cornelli and Li's (2002) model, it is a big 'No' in Gomes' (2001) model. The fundamental feature that makes the arbitrageurs stand out as a good candidate to solve the free-rider problem in Cornelli and Li's (2002) model is their short-termism. However, in the hold-out context of Gomes' (2001) model, short-termism turns out to be a bad thing. If the bidder knows that those short-term investors are likely to hold out the bid, it might not even care to offer high pre-emptive bid or revise the bid upward. In the event that the bidder walks away, it is the short-term arbitrageurs that burn their fingers[14]. In fact, other larger shareholders are better than the arbitrageurs in playing the hold-out game because they are more likely to have longer investment horizon. This can be seen as a major weakness of Gomes' (2001) model.

Another weakness of the Gomes' (2001) model is specific to the UK context. One of the model's premises is that the free-rider problem can be resolved via freeze-out style offers. In the UK, freezeout mechanism cannot be applied to mandatory bids. Under the

[14] We would like to thank the PhD third review panel for suggesting this possibility.

UK City Takeover code, a mandatory bid is triggered when a party acquires 30% or more of the target's voting equity[15]. A mandatory bid succeeds when the bidder gets only 50.1% and cannot wait to get 90% of targets voting equity. This means that the bidder is hampered from enforcing the freeze-out on minorities. This may affect the incentives of small shareholders to hold-out i.e. they don't have to fear a freeze-out and can still free-ride. Due to these weaknesses, we will base most of our empirical work on Cornelli and Li's (2002) model.

Although the two models specify different roles for the arbitrageurs to play in the merger process, one condition for them to assume these roles is that the arbitrage community accumulate large blocks of shares after the bid is announced. Interestingly, even though the arbitrageurs have the power to influence the outcome of bid, if the piece of information about their power was already reflected into price, there would be no advantage for the arbitrageurs. In that case, the arbitrageurs' ability to influence the bid outcome does not translate itself into abnormal return. As a direct consequence, the arbitrageurs would have no incentive to trade. Golbe and Schranz (1994) suggest one solution to the trading problem, that is, the bidder tips insider information to the arbitrageurs to attract them into the game.

Cornelli and Li (2002), however, show that it does not require any kind of insider information to induce the arbitrageurs to participate in the takeover contest. An arbitrageur enters the trading game without any prior advantageous knowledge about the outcome of the bid. The only advantage he possesses is that he knows his presence and it has been already shown that his presence can influence the bid outcome. Therefore, as long as his presence is not revealed, the arbitrageur has an informational advantage about the final outcome and the terms of the bid. Thanks to the advantage, the arbitrageur has higher reservation price about the target stock compared to other target shareholders. This enables the arbitrageur to accumulate target shares. Thus, the key factor for the arbitrageur to trade advantageously in the target shares is to hide his presence. In Cornelli and Li's model, the arbitrageur can hide his trading through two

[15] For a thorough review about mandatory bids, please see Sudarsanam (2010, ch18)

channels. First, the trading of noise traders in the same direction with the arbitrageur provides the camouflage for his presence (Kyle and Vila, 1991). Second, the arbitrageur only acquires the target shares up to the threshold that triggers disclosure obligation (e.g. in US, UK, it is 5%, 1% of the target shares respectively[16]). Overall, it is possible that the arbitrage community can accumulate large block of target shares without revealing their presence, which enables them to make abnormal return from their ability to influence the bid outcome.

Next, we present some empirical evidence on the different roles that arbitrageurs play in the takeover process.

Empirical evidence

In practice, as the arbitrageurs are often the professional money managers, who invest on behalf of other investors for a hefty fee, it is unlikely that the arbitrageurs are the naive investors who invest in a random portfolio of takeover bids. Paradoxically, almost all of the extant empirical studies, which focus on the profitability of the merger arbitrage strategy, nevertheless, implicitly assume that the merger arbitrageurs are no better than the naive investors. The common feature of these studies is the way the arbitrage portfolio is formed. A takeover bid is added to portfolio whenever data necessary for computing arbitrage return are available. Obviously such arbitrage portfolio is also accessible to the average investors in the market.

The real-world arbitrageurs are expected to be better than the average investors. The passive arbitrageurs possess superior knowledge about the bid outcome, thereby having the ability to select the best bids for their investment. The active arbitrageurs leverage their stakes to influence the outcome of the bid in a way that help them earn higher profits. The evidence about the passive role and the active role of arbitrageurs is

[16] The maximum amount of target shares that trigger disclosure obligation varies among countries. In the US, the threshold is 5%; in the UK it is 1%. Please see Kenyon-Slade (2004) for more details.

nonetheless scant. We are aware of only two empirical studies by Lacrker and Lys (1987) and Hsieh and Walkling (2005) on this subject.

Larcker and Lys's (1987) study

Larcker and Lys (1987) are the first to suggest that the arbitrageurs may possess superior knowledge about the odd that the takeover bid will eventually succeed or fail compared to the average investors in the market. The public knowledge, also the average investors' knowledge, about the outcome of the takeover bid is reflected in the market price of the target stock. The target stock market price P can be decomposed into:

$$P = (1 - \pi)P_{NS} + \pi P_S \tag{6}$$

where P_{NS} is the price of the target stock if the bid fails and P_S is the price of the target stock if the bid is successful. P_S is indeed the final offer price. π is the probability of bid success perceived by the average investors in market. From equation (6), the market implied probability of bid success can be calculated as:

$$\pi = (P - P_{NS})/(P_S - P_{NS}) \tag{7}$$

Larcker and Lys (1987) argue that the arbitrageurs are better informed about the outcome of the bid if the actual or the ex post success rates of the takeover bids that they invest in are greater than the market-implied probability of success calculated using equation (7). The authors find supporting evidence.

Larcker and Lys (1987) examine 111 US cash tender offers, in which arbitrageurs have investment positions. The arbitrageurs are identified through 13-D filings. In the US, when an investor owns 5% or more of the outstanding shares, he must file a 13-D form, which clearly states the purpose of the investment. Larcker and Lys (1987) define arbitrageurs as those whose stated purpose in the 13-D filings is "arbitrage or other business activities". To calculate the market implied probability of bid success, the P is measured as the market price of the target stock on the last day that the arbitrageurs acquire the target stock as stated in the 13-D filings. P_S is the offer price and P_{NS} is market price of the target stock 30 days prior to bid the bid announcement date.

Larcker and Lys (1987) find that the actual success rates of these 111 cash tender offers (97.12%) is significantly larger than the probability of success perceived by the market when the arbitrageurs set up the arbitrage positions (81.11%). Furthermore, the arbitrage positions generate substantial annualized abnormal return of 14.51%. According to Larcker and Lys (1987), the arbitrageurs must have engaged in costly information acquisitions, and therefore are better informed about the bid outcome. The abnormal return from the arbitrage position compensates the arbitrageurs for the information costs. The evidence provides support for the passive role of the arbitrageurs in the takeover process.

Hsieh and Walkling's (2005) study

Hsieh and Walkling's (2005) study is the first attempt to empirically shed light on the active role of the arbitrageurs. Prior to this study, research on the active role is purely theoretical. We already conducted a thorough review of two theoretical models by Cornelli and Li (2002) and Gomes (2001) earlier in this section. In Larcker and Lys's (1987) study, there is no suggestion that the result may be driven by the active role of the arbitrageurs. The finding that the success rates of those takeover bids in which the arbitrageurs invest are greater than the probability of bid success perceived by the average investors may stem from the arbitrageurs' ability to influence the bid outcome. As described in Cornelli and Li (2002), the presence of arbitrageurs facilitates the takeover bid by resolving the free-rider problem. Thus, the finding by Larcker and Lys (1987) can also be validly interpreted as a manifestation of the arbitrageurs' active role.

Hsieh and Walkling (2005) recognize that it is difficult to distinguish between the passive and the active role in empirical work. Typically we can observe the correlation between the presence of arbitrageurs in the takeover bid and a favourable bid outcome but we cannot be sure about the direction of the causality i.e. whether the presence of the arbitrageurs leads to the favourable outcome or the favourable outcome attracts more arbitrageurs' presence into the game. Even when we can use some sophisticated econometric techniques to uncover the direction of the causality, the evidence can only confirm the passive role not the active role. In case the favourable outcome attracts more arbitrageurs into the game, it is clearly the evidence supporting the passive role only. In the event that the presence of the arbitrageurs helps bring about the favourable outcome, it is not clear that this evidence supports active role or passive role. When the arbitrageurs acquire large stakes in the target firm, their presence can influence the bid outcome but it does not show whether they actively leverage their stakes to alter the outcome of the takeover bid. The active role must be behaviourally observed. We cannot confirm the active role based on the relationship between the presence of arbitrageurs and bid outcome only.

The data about how arbitrageurs actually behave is not available; only the data about their holding of the target stock is available. Hence, in empirical work, a compromise is often made. If we can infer from the data that the arbitrageurs' holding of target stock can exert influence on the outcome of the takeover bid, such piece of evidence is interpreted as supporting evidence for the active role of arbitrageurs. This is what Hsieh and Walkling (2005) aim to establish in their study.

On a sample of 608 US cash and stock takeover bids from 1992 to 1999, Hsieh and Walkling (2005) investigate the arbitrageurs' ability to influence the outcome and the terms of the bid. In particular, they test the prediction of Cornelli and Li's (2002) theoretical model that the arbitrage holding of the target stocks is positively related to bid premium and the probability of bid success.

Different from Larcker and Lys (1987) who use 13-D filings to identify arbitrageurs, Hsieh and Walkling (2005) use 13-F filings. Under the US laws, institutions are required, on quarterly basis, to disclose the details of their holdings that have value greater than $100,000. As these institutions are not required to state whether they are merger arbitrageurs, it is necessary to employ an empirical procedure to identify arbitrageurs. Hsieh and Walkling (2005) define arbitrageurs as those who increase their holding of the target stocks from the quarter before the bid announcement date to the quarter after the bid announcement date in at least 6 takeover bids in the sample. The logic behind the procedure is that arbitrageurs should be those who frequently buy target stock after the bid announcement, and hence provide the insurance against the deal completion risk for the target shareholders. When the arbitrageurs are identified, the arbitrage holding of target stocks is sum of all the increases in holding from the quarter the before the bid announcement date to the quarter before the bid ends.

Hsieh and Walkling (2005) argue that the passive role and the active are not mutually exclusive. Stated differently, the arbitrageurs can play both roles at the same time. This means that the direction of the causal link between arbitrage holding and bid outcome variables namely the bid premium and the probability of bid success can come in both ways. As the passive arbitrageurs have the ability to select bids with more favourable outcome, bids with higher premium and higher the chance of success can attract more arbitrage holdings. At the same time, higher level of arbitrage holding can increase bid premium and the probability of bid success. Thus, arbitrage holding, bid premium and probability of bid success are likely to be jointly determined in equilibrium. In other words, these variables might be endogenously related.

Employing a system of simultaneous equations to control for the endogeneity, Hsieh and Walkling (2005) find support both the active role and passive role of the arbitrageurs. In particular, arbitrage holding is greater in those bids with higher ex post arbitrage return, higher bid premium and higher chance of bid success. At the same time the bid premium and the probability of bid success are found to increase with the level of merger arbitrage holding. These relations hold even when the market's assessment of bid success and a host of other factors that can affect the bid outcome are controlled for. The authors use the arbitrage spreads at different points of time after the bid announcement as the proxy for the market's assessment of the bid success. With a large spread, the market would perceive that the bid is less likely to succeed and vice versa. The finding is consistent with both the passive role and the active role. The arbitrageurs appear to be better than the average investors in the market in assessing the outcome of the takeover bid and their presence can influence the bid outcome.

To sum up, the evidence shows that arbitrageurs are better than the average investors in the market and can play both the passive and the active role. In their passive role, the arbitrageurs have superior knowledge about the outcome of the bid. As an active investor, the presence of the arbitrageurs can influence the bid outcome. However, as mentioned earlier, Cornelli and Li (2002) postulate that one condition for arbitrageurs to enter the game and influence the bid outcome is that they can hide their presence. There is hardly any evidence about this condition and further research is therefore expected.

2.4 Literature gap and research question

The determinants of merger arbitrage returns have been investigated both theoretically and empirically in the spirit of three separate but not mutually exclusive hypotheses namely the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageur's role hypothesis. Except for the evidence on the risk-based hypothesis, the evidence on the others is scanty and inconclusive. Even for the risk based hypothesis, the conflicting evidence still exists. Under the risk-based hypothesis, most studies report that the strategy can persistently earn substantial positive returns in excess of the compensation for systematic risk. Mitchell and Pulvino (2001) find a non-linear pattern in the strategy's risk-return relationship in the US market. However, Maheswaran and Yeoh (2005) find little evidence about the non-linearity in the Australian market. Although these two studies document different results, little is known about why such a difference exists. We postulate that the difference may be attributable to the difference between the takeover regulatory environment between the US and Australia.

Under the limited arbitrage hypothesis, the review in Section 2.3.2 points out that the extant evidence in the US market is largely inconclusive about whether arbitrage cost theory or price pressure theory provides a better explanation about the source of the excess return to the strategy. As for the arbitrageurs' role hypothesis, there are only two empirical studies examining the roles of the arbitrageurs in the takeover process. The importance of the anonymity condition for the arbitrageurs to influence the bid outcome has hardly been tested. If the condition is of material importance, it can be speculated that in the jurisdictions where the stringent disclosure rules are imposed, it would be very difficult for arbitrageurs to exert any influence on the bid outcome.

Most of the empirical evidence is reported only for the US samples. For the non-US samples, to our best knowledge, only two studies by Karolyi and Shannon (1999) and Maheswaran and Yeoh (2005) empirically examine the source of merger arbitrage return for Canadian and Australian markets respectively. Compared to the US studies, the sample size of these non-US studies is very small. The sample size is 37 for the Canadian study and 193 for the Australian study. Thus, the robustness of these non-US studies should be put into question. What is more, these non-US studies only test the risk-based hypothesis. The empirical evidence on the limited arbitrage hypothesis and arbitrageurs' hypothesis is only limited to US samples.

Factors influencing return to merger arbitrage include takeover regulatory rules that affect the timing, disclosure of information, revision of offer terms, ability of the bidder to withdraw the offer, and the timetable for the merger process to be completed. These regulatory rules are different between the US and other countries. Thus, the results of the research in the US are not easily generalisable to other markets. The inconclusive empirical evidence from the US studies and the lack of evidence from other markets represent a big gap in the literature on the determinants of merger arbitrage return.

This doctoral study seeks to fill this gap by investigating the profitability of the strategy and the factors that determine the return to the strategy in the UK market. As the UK is the second most active merger and acquisition market in the world (Sudarsanam, 2003), the size of the UK sample employed in this study is much larger than other non-US samples. Hence, this study presents the first rigorous empirical study on merger arbitrage in a market other than the US market. The UK takeover regulatory regime provides a distinctive setting different from the US regime. This study is the first to examine the impact of takeover regulation on the factors that determine merger arbitrage return. The primary research question is:

What is the magnitude of merger arbitrage return in the UK market and what are the factors that determine the return?

To answer the question, we conduct three empirical projects to test the three corresponding hypotheses namely the risk-based hypothesis, the limited arbitrage hypothesis, and the arbitrageurs' role hypothesis in the UK context. Next, we briefly discuss each project.

Risk-based hypothesis

This project is the logical starting point to investigate the determinants of the return to the merger arbitrage strategy in the UK market. In this project, we estimate the size of the return to the merger arbitrage portfolio and examine the role of systematic risk in explaining the source of the return. As the hypothesis is grounded upon the assumption of a perfect capital market, it has been shown in Section 2.3.1 that in this setting systematic risk should be the sole determinant of the return to the strategy. Based on the existing empirical evidence from other markets, it is expected that the strategy can generate significant positive return in excess the benchmark for systematic risk.

In addition to examining to what extent systematic risk can help shed light on the source of the return to the strategy, we also explore the impact of the UK takeover regulations on the risk-return characteristics of the merger arbitrage portfolio. For the US market, Mitchell and Pulvino (2001) find that the risk-return relationship differs between the bear and bull markets. However, Maheswaran and Yeoh (2005) do not find such pattern in the Australian market. Although these studies report the different empirical results, they do not go far enough to uncover the reasons underlying the difference. In this study, we make an inquiry into the difference and postulate that the difference in the risk-return pattern of the strategy in different markets may be attributable to the difference in the takeover regulations. We establish hypotheses based on such inquiry and perform empirical tests. All empirical tests and results of the risk-based hypothesis are reported in Chapter 4.

Limited arbitrage hypothesis

The second project moves away from the perfect capital market setting to identify and test different types of risks, costs and constraints other than systematic risk that the real-world arbitrageurs face in implementing the strategy. As reviewed in Section 2.3.2, under the limited arbitrage hypothesis, there are two competing theories about the determinants of the arbitrage excess return. The empirical evidence in the US is still inconclusive about which theory is correct. In this project, by re-examining this issue, we can help to resolve the conflicting evidence in the US market. Further, we also look at the impact of a range of arbitrage costs and risks on the arbitrage excess return, that is, transaction costs, holding costs, idiosyncratic risk, and short-sales constraints. All empirical tests and results of the limited arbitrage hypothesis are reported in Chapter 5.

Arbitrageurs' role hypothesis

In the third project, we explore how the roles that the arbitrageurs can play in the takeover process can help explain the return to the strategy. We follow the approach suggested by Baker and Savasoglu (2002) and Hsieh and Walkling (2005) to identify arbitrageurs and their holding of the target stocks. We test whether arbitrage holding can explain the cross-sectional variation of the return to the strategy after a host of factors that can determine the bid outcome and the market's assessment of the bid outcome are taken into account. A significant relationship between arbitrage return and arbitrage holding would indicate that the arbitrageurs are better than the average investor in the market in selecting the takeover bids, investment in which can yield higher risk-adjusted return.

What is more, we test whether the level of arbitrageurs' holding of target stocks has positive impact on bid premium and the probability of bid success as predicted by Cornelli and Li's (2002) model. One of the premises of the model is that the arbitrageurs can hide their presence when acquiring stakes in the target. The anonymity gives the arbitrageurs an edge in trading with other investors in the market enabling them to earn abnormal return. The strict UK disclosure rules during the takeover period make the anonymity assumption rather tenuous. As argued later in Chapter 6, since the disclosure rules during the takeover period are much stricter in the UK than in the US, we would expect different results about the UK arbitrageurs' ability to influence the bid outcome. All empirical tests and results of the arbitrageurs' role hypothesis are reported in Chapter 6.

2.5 Chapter summary

This chapter surveys the existing literature on the determinants of the return to the merger arbitrage strategy. Research on merger arbitrage can be grouped under three hypotheses namely the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageurs' role hypothesis. The risk-based hypothesis concerns about how systematic risk can help explain the return to strategy and the risk-return characteristics of the strategy. The extant empirical evidence unanimously report that the strategy can generate significant positive return in excess of the benchmark for systematic risk. As far as the risk-return characteristics of the strategy are concerned, the returns to the arbitrage portfolio are found to be related to the market risk in a non-linear way. In particular, the strategy has zero market risk in normal market condition but has significant positive market risk during serve market downturn. The empirical evidence on the non-linear pattern is, however, confined to the US market. The study in the Australian market reports no supporting evidence for the non-linear pattern.

The fact that the strategy can generate substantial return in excess of the compensation for bearing systematic risk serves as the baseline for the limited arbitrage hypothesis and the arbitrageurs' role hypothesis. These hypotheses attempt to explain the excess return to strategy, the part of the return unexplained by systematic risk. Under the limited arbitrage hypothesis, the excess return exists due to the additional costs, risks and constraints that the arbitrageurs face in implementing the strategy. Under the arbitrageurs' role hypothesis, the arbitrageurs earn abnormal return thanks to their ability to select the best takeover bids for the arbitrage portfolio or, most interestingly, to their ability to influence the final outcome and the terms of the bid. The empirical evidence for these two hypotheses is scanty, inconclusive and limited to US samples.

Based on the literature survey, it is clear that most of the research on merger arbitrage focus on testing the risk-based hypothesis. There is little evidence on the limited arbitrage hypothesis and the arbitrageurs' role hypothesis. Furthermore, the majority of evidence is concentrated in the US market. Surprisingly, given that the UK is the second most active merger and acquisition market in the world after the US, there is still no empirical evidence on merger arbitrage for the UK market. As the UK has distinctive takeover regulatory regime, the US results are not easily generalizable to the UK context. This represents the gap in the literature. This doctoral study aims to fill the gap by investigating the source of the return to the merger arbitrage strategy in the UK context. The research question of the study is:

What is the magnitude of merger arbitrage return in the UK market and what are the factors that determine the return?

To tackle the research question, we conduct three empirical projects testing the three hypotheses identified from the literature survey in the UK context. In the first project testing the risk-based hypothesis, we estimate the return to the strategy and examine how systematic risk can help explain the source of the return. Given the extant empirical evidence, it is expected that the strategy will generate positive abnormal return in excess of a risk-adjusted benchmark return. However, the pattern of abnormal return during bull and bear markets is expected to be different in the UK from that in the US due to differences in their takeover regulations. The other two projects are aimed at uncovering the factors behind the abnormal return to the strategy. In the second project testing the limited arbitrage hypothesis, we test the limits to arbitrage model in terms of the risks and costs that limit the arbitrage activities. In the third project testing the arbitrageurs' role hypothesis, we focus on the roles that the arbitrageurs play during the takeover process and test for their impact on merger arbitrage return.

In the next chapter, we discuss the data and some common methodological issues for the three empirical projects.

TABLES

Table 2.1: Summary of merger arbitrage abnormal return from extant studies

This table summarizes the results of 9 studies that apply the Capital Asset Pricing Model (CAPM), Fama and French (1993) three-factor model (F&F) and contingent-claim approach to calculate the risk-adjusted return to the merger arbitrage strategy. Two approaches are applied to calculate the merger arbitrage portfolio return. In the event-time approach, the return to the investment in each bid is computed for the period starting a few days after the announcement date ending at the date, on which the bid is completed or terminated; the portfolio return is the average of the annualized returns from all bids in the sample. In the calendar-time approach, a bid is included in the portfolio at a few days after the announcement date and excluded from the portfolio at the date, on which the bid is competed or terminated. The portfolio return at each point of time is the average of the returns from all active bids in the portfolio at that time. The calendar time approach produces a time series of merger arbitrage portfolio return.

Studies	Sample	Annualized abnormal returns		
		CAPM	**F&F**	**Contingent Claim**
	Event-time approach			
Larcker and Lys (1987)	111 US cash tender offers from 1977 to 1983	14.51%	N/A	N/A
Dukes (1992) et al.	761 US cash tender offers from 1971 to 1985	172%	N/A	N/A
Thosar and Trigeorgis (1994)	63 US cash tender offers from 1981 to 1987	42.08%	N/A	N/A
Karolyi and Shannon (1999)	37 Canadian cash tender offers in 1997	33.90%	N/A	N/A
	Calendar-time approach			
Mitchell and Pulvino (2001)	4750 US cash and stock deals from 1963 to 1999	9.90%	9.25%	10.30%
Baker and Savasoglu (2002)	1901 US cash and stock deals from 1981 to 1996	9.77%	7.31%	N/A
Jindra and Walkling (2004)	362 US cash tender offers from 1981 to 1995	N/A	26.82%	N/A
Maheswaran and Yeoh (2005)	193 Australian cash deals from 1991 to 2000	10.69%	9.90%	N/A
Branch and Yang (2006)	1309 US cash and stock deals from 1990 to 2000	22.42%	N/A	N/A

Appendix 2.1: The pricing mechanism of financial assets

To make a parrot into a learned financial economist, he only needs to learn the single word "arbitrage" (Ross, 1987)

As the aim this study is to shed light on the source of the return to merger arbitrage strategy, a good understanding of the "arbitrage" concept as well as how asset is priced in financial market is a pre-requisite. In this section, we will show two points:

- First, in theory arbitrage is a unique investment strategy that requires no investment and entails no risk but yields positive return;

- Second, financial asset is priced on a risk-return tradeoff basis. Specifically, assets in high risk class must offer higher expected return than those in the low risk class.

Arbitrage can be deemed as one of the most important concepts in finance theories. The definition of this concept therefore can be found in almost all standard finance textbooks. Hull (2005) defines arbitrage as the trading strategy that takes advantage of two or more securities being mispriced relative to each other.

A simple example of the mispricing which gives rise to an arbitrage opportunity is the situation whereby two fundamentally identical assets are trading at different prices. Suppose two assets A and B have exactly the same payoffs in all future states and the likelihood of realizing the payoff in each state is also the same for the two assets. It is evident that A and B should have the same price. If the price of A is £x higher than the price of B (x is positive), an arbitrage opportunity would arise from this relative mispricing between A and B. In this case, A is said to be relatively overpriced and B is relatively underpriced. To capture this opportunity, an arbitrageur, the one who conduct the arbitrage strategy, will simultaneously purchase B, the underpriced asset, and sell short A, the overpriced asset. Short selling is defined as the act of selling a particular asset which is not owned by the seller. In this example, to short sell A, the arbitrageur needs to borrow A in the market for securities loan. If capital markets are perfect in the sense that there are no trading costs as well as no restrictions on the market for securities loan, the arbitrageur can use the proceeds from short selling A to purchase B. In doing so, the arbitrageur has zero net investment and can realize upfront profit equivalent to £x, the size of the mispricing. Furthermore, since A and B have the same future payoffs, the arbitrageur knows with certainty that the arbitrage strategy has zero net future cash flows. In this sense, the arbitrage strategy entails no risk.

Given the ex ante knowledge that the arbitrage process is riskless, investment-free but yields positive profits, the arbitrageur can take an arbitrarily large position to bet on the mispricing. The direct result of this process is the surge in both the demand for B and the supply of A, which will drive up the price of B and lower the price of A. The arbitrage process stops only when the two assets trade at the same price as dictated by their fundamental characteristics and the market equilibrium price of the two assets is obtained. When the market price is in equilibrium, no-arbitrage opportunity is permitted. Any deviation from the equilibrium will give rise to an arbitrage opportunity and the arbitrage process will drive asset price back to the pricing equilibrium level.

The example illustrates two important points about the characteristic of arbitrage and the role of arbitrage in the pricing of financial asset. First, arbitrage is a unique trading strategy because it requires no investment, entails no risk but yields positive return. Second, due to its unique characteristics, arbitrage plays a crucial role in how financial assets are priced. While in economics the equilibrium price is obtained when supply is equal to demand, in finance the pricing equilibrium on securities market is reached and maintained when no arbitrage opportunity is permitted.[17]

[17] The no-arbitrage condition is the cornerstone of many financial theories. Ross (2001) terms the condition as the fundamental theorem of finance The no-arbitrage argument is also the centre of the famous irrelevance proposition of Modigliani and Miller (1961; 1958) which lays out the foundation for corporate finance literature. In a review of asset pricing literature, Campbell (2000) states that the theoretical developments in asset pricing over the last 20 years have taken place within a well-established paradigm which emphasizes the structure placed on financial asset returns by the assumption that asset markets do not permit the arbitrage opportunity.

In our simple example, the arbitrage process helps maintain the law of one price in financial market i.e. two identical assets cannot have the different price. This result can be generalized to the case where two securities having the same risk should offer the same expected return. As a financial asset is nothing more than an abstract right to an uncertain income stream (Mashruwala et al., 2006; Scholes, 1972), a rational investor when making investment decision in an asset only cares about whether the expected return on the investment sufficiently compensates for the risk stemming from the uncertainty about the asset's future income stream. Thus, two assets having the same risk can be considered identical. If these assets offer different expected return, an arbitrage opportunity would arise. By setting a similar arbitrage position as in the above example, an arbitrageur can gain positive expected return without incurring any investment and risk. The arbitrage process stops only when the two assets offer the same expected return and a pricing equilibrium that allows no arbitrage opportunity is obtained. A similar arbitrage situation can also arise when two assets that offer the same expected return but have different risk.

To this stage we obtain the core idea of the pricing process in financial market. All rational investors will price an asset on a risk-return basis. The no-arbitrage condition guarantee that the expected return on the investment in a particular asset is solely determined by how risky the asset is. Stated differently, the compensation for risk is the sole determinant of asset returns. The pricing process in financial market based on risk-return tradeoff is fundamental to our discussion of different hypotheses that explain the source of merger arbitrage return.

Chapter 3: DATA AND METHODOLOGY

3.1 Introduction

To tackle the research question: '*What is the magnitude of merger arbitrage return in the UK market and what are the factors that determine the return?*', we carry out three empirical projects, each of which corresponds to one of the three hypotheses namely the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageur's role hypothesis. These three empirical projects employ different methodologies and datasets

First, in the risk based hypothesis, we estimate the profitability and the risk-return characteristics of the merger arbitrage strategy in the UK market. The analysis is conducted at portfolio level. Three calendar-time portfolio return series are constructed based on different weighting schemes. The dominating econometric technique is time series regression analysis. The sample of takeover bids cover a 21 year period from 1987 to 2007.

Second, in the limited arbitrage hypothesis, we examine the impact of different types of risks and costs on the abnormal return to the strategy. The level of analysis is on individual takeover bids. The method of analysis is cross-sectional regression. As additional data on each individual takeover bid are required and some data are collected manually, the sample of takeover bids is restricted to cover 11 year period from 1997 to 2007.

Third, in the arbitrageurs' role hypothesis, we investigate how different roles that the arbitrageurs play in the takeover process provide an answer to the source of the abnormal return to the strategy. In particular, we examine the relationship between the arbitrageurs' holding of target stocks and arbitrage return, bid premium and the probability of bid success. The level of analysis is on individual takeover bids and the method of analysis is cross-sectional regression. Special emphasis regarding methodological issues will be placed on solving the possible endogeneity problem in the cross-sectional regression analysis. As we need to manually collect some data on individual takeover bids, the sample of takeover bids is restricted to cover 11 year period from 1997 to 2007. This is the same as the sample of takeover bids used in the second project testing the limited arbitrage hypothesis.

It is clear that the methodology and data requirements for each empirical project are different from one another. Thus, we will describe the methodology and data for the three empirical projects in detail when they are conducted in the following chapters. In this chapter, we only discuss the methodology and data issues that are common to all three empirical projects.

As far as data are concerned, all three projects require a sample of takeover bids as the merger arbitrage strategy is essentially the bet on the outcome of the bid. Thus, we discuss the process of obtaining the sample of takeover bids as the common issue for the three empirical projects in this chapter.

As for methodology, the method to calculate the arbitrage return and the bid outcome model are considered two common issues. The rationale for the former is quite obvious. The three empirical projects are aimed at shedding light on the source of the return to arbitrage strategy. For the latter, the bid outcome model is designed to estimate the probability of bid success, which is the input to calculate one important variable in the second project testing the limited arbitrage hypothesis. In the third project on the arbitrageurs' role hypothesis, the bid outcome model is utilized to examine the relationship between the presence of arbitrageurs and the probability of bid success. Thus, we discuss the method to calculate arbitrage return and the bid outcome model in this chapter.

This chapter is structured as followings. Section 3.2 describes the data sources and the process to select the sample of takeover bids. Section 3.3 discusses the methodology to compute the arbitrage return to the investment in each takeover bid. Section 3.4 describes the model to estimate the probability of bid success. Section 3.5 summarizes the chapter.

3.2 Data and sample of takeover bids

3.2.1 Data sources

In this project, three databases will be employed to select the sample of takeover bids and to collect data for other variables. We will briefly describe each database.

(1) Thomson online SDC. This database is the main source to select the sample of takeover bids. Most of the fundamental information about a takeover bid is available in SDC in a tabulated and downloadable format.

(2) Datastream. We use this database to collect financial data of the target and the bidder firm. In this project, to calculate merger arbitrage return, we need share prices, dividends for the period covering the duration of the takeover bids.

(3) Perfect Filings. This database contains all filings that firms are required to submit to regulatory authorities. The fillings are classified according to UK regulations; hence searching for a particular type of filings is very convenient. We use this database to fill in the missing information of the data taken from Thomson online SDC. As will be discussed in section 6.4, this database is the source based on which we identify arbitrageurs, their holding of the target stocks, and other variables.

3.2.2 Sample of takeover bids

We use two samples of takeover bids for the three empirical projects. In the first project testing the risk-based hypothesis, the sample covers 21 year period from 1987 to 2007. The second and the third project use the same sample of takeover bids, which is a subset of the sample for the first project. This second sample is restricted to cover 11 year period from 1997 to 2007.

Sample for risk-based hypothesis

While the previous studies on the non-US markets only consider samples of cash bids, in this study we also include stock bids in our UK sample. The inclusion of the two most popular types of takeover bids in the sample would ensure that our simulated merger arbitrage return series closely mirrors the real world. Data about the UK takeover bids are taken from Thomson on-line SDC database. Because SDC recorded only a small number of bids prior to 1987, our sample period starts from 01/01/1987 and ends at 31/12/2007.

To be included in our initial sample, several criteria must be met.

- The bidder is seeking to control more than 50% of the target shares.

- The bid announcement date is from 01/01/1987 to 31/12/2007

- The bid's consideration structure is either pure cash or pure stock. In cash bids, bidder offers cash in exchange for target's shares. In stock bids, a fixed number of bidder's shares are exchanged for each target share.

- For cash bids, target must be a public company listed on a UK stock exchange; for stock bids, both bidder and target are required to be publicly traded companies.

These criteria result in the initial sample of 1392 takeover bids. Among these bids, 38 are excluded because they are just rumours or bidders' intention. The information about the announcement date and the resolution date are missing for a number of bids. After doing a search on Perfect Filings and Factiva to fill in the missing information, we discard further 97 bids. We also drop another group of 89 bids because the announcement date and the resolution date[18] as recorded by SDC are the same making it impossible to invest in those bids.

The final step in selecting the sample of the UK takeover bids is to get the financial data for the target and the bidder firms. We require that data about share price and market

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[18] For successful takeover bids, the resolution date is the date on which the bid is declared 'effective' or 'unconditional' as recorded in SDC. For failed bids, the resolution date is the date on which the bidder withdraws from the bid.

value over the offer period are available from Datastream for target firms in the case of cash bids and for both target and the bidder firms in case of stock bids. This requirement further reduces the initial sample by 63 bids.

The final sample for the risk-based hypothesis consists of 1105 UK cash and stock takeover bids. Since there is no bid in January 1987, the sample starts from 01/02/1987 and ends at 31/12/2007.

Sample for limited arbitrage hypothesis and arbitrageurs' role hypothesis

The second sample of takeover bids for the limited arbitrage hypothesis and the arbitrageurs' role hypothesis is the subset of the first sample for the risk-based hypothesis. The second sample is obtained from the first sample by imposing 4 additional criteria:

- The bid announcement date is from 01/01/1997 to 31/12/2007. This criterion reduces the first sample by 304 bids.

- The bid duration, which is the number of days between the announcement date and the resolution date, is at least 21 days. For successful bids, the resolution date is the date on which the bid is declared to be effective or unconditional in case the effective date is not available in SDC. For failed bids, the resolution date is the date on which the bid is withdrawn. Under Rule 31.1 of the City Code, an offer must remain open for a minimum of 21 days following the date on which the offer document is posted. This justifies the requirement. In line with this criterion, 56 takeover bids are excluded.

- Data about the total return index on the target stocks are available in Datastream for the period starting 160 days prior to the bid announcement and ending at the bid resolution date defined above. This criterion reduces the sample by 49 bids.

- Finally, data about the target firm must be available in Perfect Filings. This criterion ensures that additional data about the target can be taken from the database. Under this criterion, 43 bids are discarded.

The final sample for the limited arbitrage hypothesis and the arbitrageurs' role hypothesis include 653 takeover bids from 01/01/1997 to 31/12/2007. The sample selection process is summarised in Table 3.1

[Insert Table 3.1, page 82 here]

3.3 Arbitrage return calculation

The return to the arbitrage position in a single bid on day t (day *0* is the announcement date) is the ratio of the change in the position value on day t to the position value on day $t-1$. As the particular investment tactics are dependent on the bid's form of payment, the return calculation differs between cash and stock bids.

For cash bids, because the arbitrage position includes only a long position in the target stock, the position value per one stock is the market price of the target stock. The change of the position value at day t is computed based on the changes in the target stock price and the dividend paid by the target firm. The equation to calculate the daily return to a position in a cash bid on day t is:

$$R_{it} = \frac{P_{it}^T + D_{it}^T - P_{it}^T}{P_{it-1}} \tag{8}$$

where R_{it} is the return to the investment in bid i on day t, P_{it}^T and P_{it-1}^T are the target stock price at the close of the market on day t and $t-1$ respectively (superscript T refers to "target"), D_{it}^T is the dividend paid by the target firm of bid i on day t. In case the cash bid is revised, equation (8) is still applicable. As the arbitrageurs only hold a long position in the target stocks, the revision does not affect the structure of the investment in a cash bid.

The merger arbitrage position in a stock merger includes a long position in the target stock and a short position in the bidder stock. To capture the arbitrage spread, for every long position in one target stock, the arbitrageurs short δ bidder stocks, where δ is the exchange ratio i.e. the number of bidder stocks in exchange for one target stock. As the arbitrage position is created in day 1, for every long position in the target stock, the arbitrageurs receive the proceeds from the short position in the bidder stock equivalent to δP_{i1}^{B}, where P_{i1}^{B} is the price of the bidder stock of bid i on day 1 (superscript B refers to "bidder"). In practice, the arbitrageurs have to put the proceeds from the short position as the cash collateral and may earn interest on the cash collateral (D'Avolio, 2002). Assuming that the rate of return on the cash collateral is the risk-free rate, cash collateral plus cumulative interests on day $t-1$ per one bidder stock being shorted is $P_{i1}^{B}(1+r_f)^{t-2}$, where r_f is the daily risk-free rate for the period from day 1 to day $t-1$, and P_{t-1}^{B} is the bidder stock price at the close of the market on day $t-1$.

The value of the arbitrage position on day $t-1$ is the amount that arbitrageurs receive if they choose to close the position. In particular, for every long position in one target stock, the arbitrageurs receive the cash from selling the target stock (P_{it-1}^{T}), the cash collateral plus the cumulative interests from day 1 ($\delta P_{i1}^{B}(1+r_f)^{t-2}$) ; the arbitrageurs have to pay to buy back the bidder stocks (δP_{it-1}^{B}). The change in the value of the arbitrage position is computed based on the movement of the bidder and target stock price, the dividend paid by the bidder firm and the target firm and the interest on the cash collateral. The final equation to calculate the daily return to the arbitrage position in a stock bid is:

$$R_{it} = \frac{(P_{it}^{T} + D_{it}^{T} - P_{it-1}^{T}) - \delta(P_{it}^{B} + D_{it}^{B} - P_{it-1}^{B} - r_f P_{i1}^{B})}{P_{it-1}^{T} - \delta[P_{it-1}^{B} - P_{i1}^{B}(1+r_f)^{t-2}]} \tag{9}$$

In case the stock bid is revised, the exchange ratio δ and hence the proceeds from shorting the bidder stock change. Thus, for stock bids that subject to revision, equation (9) cannot be used to compute the arbitrage return throughout the bid period. Following Mitchell and Pulvino (2001), when a stock bid is revised, we consider the revised bid as a new bid and apply equation (9) to calculate the return to the arbitrage position starting from the revised date to the next revised date or to the resolution date.

Due to the complexity pertaining to the calculation of the return to the arbitrage position in a stock bid, we will illustrate the calculation procedure with an example.

Example:

On 05 March 2007, Mears Group PLC made a stock offer for Careforce Group PLC. The exchange ratio is 0.455 i.e. each target stock is exchanged for 0.455 bidder stocks. Suppose the arbitrage investment started on 06 March 2007, the position would generate daily return from 07 March 2007. We will calculate the arbitrage return on two days: 07 March 2007 and 08 March 2007. In line with equation (9), the inputs required for calculating the arbitrage return include target and bidder stock price, daily risk-free rate and dividends paid by target and bidder firm. The inputs are as followings:

Date	Target stock price	Bidder Stock price
06/03/2007	£1.535	£3.520
07/03/2007	£1.565	£3.505
08/03/2007	£1.565	£3.505

The daily risk-free rate is 0.02% (per day), and there is no dividend for both bidder and target

Arbitrage return on 07 March 2007

On 06 March 2007, the arbitrage position is established. For every long position in one target stock, the arbitrageur needs to short 0.455 bidder stocks. Based on the stock price of the target and bidder firm on 06 March 2007, for each target stock:

The arbitrageur receives 3.52x0.455 = £1.602 as the short proceeds

The arbitrageurs need to pay £1.535 to buy the target stock.

In reality, the arbitrageur does not get access to the short proceeds but use it as the cash collateral. The arbitrageurs earn risk-free rate of return on the proceeds.

The daily arbitrage return on 07 March 07 is the ratio of the change in the arbitrage position value from the previous day to the position value of the previous day. Thus, we need to calculate the position value on 06 March 2007 and 07 March 2007.

The value of the arbitrage position on 06 March 2007 is the amount that the arbitrageur receives if he decides to unwind the position. In particular, the arbitrageur will receive the short proceeds (as this is the first day, hence no interest), need to pay to buy back the bidder stock and receive the proceeds from selling the target stock.

Thus, the position value on 06 March 2007 per one target stock is:

1.535 + 0.455*3.520-0.455*3.520= **<u>£1.535</u>**

On 07 March 2007, if the arbitrageur decides to close the arbitrage position, he will receive the short proceeds plus one-day interest; he needs to buy back the bidder stocks and receive the proceeds from selling the target stocks. The breakdown of the position value per one target stock on 07 March 2007 is:

Short proceeds plus interest: 0.455x3.520x(1+0.02%) = £1.6019

Buy back the bidder stock: -0.455x3.505=-£1.5948

Sell the target stock: £1.565

<u>The position value on 07 March 2007</u>: 1.6019-1.5948+1.565 = **<u>£1.5721</u>**

<u>Return on 07 March 2007: (1.5721-1.535)/1.535 = 2.42%</u>

Arbitrage return on 08 March 2007

As we already know the position value on the previous day (07 March 2007), we only need to calculate the position value on 08 March 2007 to obtain the daily return for 08 March 2007. Similar to calculation for 07 March 2007, the breakdown of the arbitrage position value per one target stock on 08 March 2007 is:

Short proceeds plus interest: 0.455x3.520x(1+0.02%)^2 = £1.6022

Buy back the bidder stock: -0.455x3.505=-£1.5948

Sell the target stock: £1.565

<u>The position value on 08 March 2007</u>: 1.6022-1.5948+1.565=**<u>£1.5725</u>**

<u>Return on 08 March 2007: (1.5725-1.5721)/1.5721 = 0.025%</u>

As can been seen from the input table, there is no change in the price of target stock and bidder stock from 07 March 2007 to 08 March 2007. The return to the arbitrage position is equal the risk-free return. The rate of return to the arbitrage position is a bit higher because the position value on 07 March 2007, the base to compute the arbitrage return, is smaller than the short proceeds, the base to compute the risk-free return.

3.4 Bid outcome prediction model

3.4.1 Model description

We estimate the probability of bid success via logistic regression. The dependent variable is the bid outcome indicator, which is equal to 1 if the bid is successful and 0 otherwise. In the takeover bid, which has only one bidder, defining whether a bid is successful is straightforward. The bid succeeds if the bidder can acquire the target. The complexity arises when more than one bidder bidding for the same target. Whether the bid is successful depends on each party's perspective. From the bidder's view, the bid succeeds only when it wins the bidding competition. From the target' view, the bid is successful when any of the bidders wins the competition. As this study purports to identify and test the determinants of the return to the merger arbitrage strategy, we take the view of the arbitrageurs.

As described in Section 2.1 and 3.3, the arbitrage investment in a cash bid includes only a long position in the target stock. Because the investment in cash bid is unrelated to the bidder stock price, it does not matter which bidder wins the bidding war. The investment in cash bid is essentially a bet on whether the target is acquired. Thus, from the arbitrageurs' perspectives, a cash bid is successful when the target is acquired by any of the bidders.

The situation is completely different for stock bids. The arbitrage position in a stock bid involves a long position in the target stock and a short position in the bidder stock. Because the arbitrage investment depends on the price of the bidder stock, which bidder wins the bidding war matters dearly to the arbitrageurs. The nature of the short position in the bidder stock is to hedge against market risk. The hedge works only if that specific bidder wins the bidding war. If the bidder other than the one whose stocks are shorted by the arbitrageurs wins the bidding competition, the hedge breaks down and the arbitrageurs might suffer severe losses due to adverse market movement. Thus, from the arbitrageurs' perspective, a stock bid is successful if the target is acquired by the bidder whose stocks are shorted by the arbitrageurs.

To sum up, the dependent variable in the logistic regression to estimate the probability of bid success is the bid outcome indicator variable which is equal to 1 if the bid succeeds and 0 otherwise. A cash bid is successful when the target is acquired. A stock bid is successful when the target is acquired by the bidder whose stocks are shorted by the arbitrageurs.

The independent variables are generally the characteristics of the bid, the bidder and the target that can be observed when the bid is announced. These variables include:

Mood of the offer (*Hostile*)

Hostile is a dummy variable, which is equal to 1 if the bid is hostile and 0 otherwise. In a hostile offer, the target management opposes the offer, whereas in a friendly one, the target management usually recommends the offer to the target shareholders. The mood of the offer is found to be the most important determinant of the bid outcome (Schwert, 2000). Walkling (1985) reports that hostile bids have about 33% lower chance to go through than friendly bids.

Multi-bidders (*MultiBidders*)

This is a dummy variable, which is equal to 1 if two or more bidders are competing to acquire the target and 0 otherwise. As discussed at the beginning of this section, the arbitrageurs' perspective on the emergence of the new rival bidders differs between cash bids and stock bids.

For cash bids, the multi-bidder situation is like a boon to the arbitrageurs. As there are more players in the bidding game, the chance that the target is acquired by one of the players will be higher. It is noted that the arbitrage position in cash bid yields a positive profit as long as the target is acquired. As a result, the multi-bidder situation reduces the riskiness of the arbitrage investment. What is more, as the new bidder typically offers a higher premium in order to win the bidding game (Betton and Eckbo, 2000; Eckbo, 2009), the expected payoff to the arbitrageurs is greater in takeover bids with multiple bidders. Thus, from the arbitrageurs' perspective, the multi-bidder situation in cash bid increases the chance of bid success and the expected profits from the arbitrage investment.

For stock bids, the multi-bidder situation, by contrast, adds more uncertainty to the bid outcome from the arbitrageurs' perspective. Walkling (1985) and Jennings and Mazzeo (1993) document that the emergence of new bidders in the bidding process decreases the probability that the initial bidder can successfully consummate the bid. As discussed earlier, for arbitrageurs, a stock bid is successful only when the initial bidder, whose stocks are shorted by the arbitrageurs, wins the bid. Thus, from the arbitrageurs' perspectives, the multi-bidder situation reduces the chance that a stock bid is successful.

Managerial ownership *(ManOwn)*

We measure managerial ownership as the percentage of target share directly owned by the target managers and their family. We obtain the data on managerial ownership from the target firm's most recent annual report prior to the bid announcement. Under the Companies Act 1985, companies are required to disclose in their annual reports the managerial ownership.

Given that the target management's attitude toward the bid has such a powerful influence on the bid outcome, it is logical that the managerial ownership should also affect the bid outcome. Significant share ownership gives managers more room to deter or facilitate the bid. The direction of the impact of the managerial ownership on the outcome of the bid depends on the mood of the offer. In hostile bids, the impact is negative as large managerial ownership helps target managers block the bid more effectively. The impact, by contrast, is positive in friendly bids because managers favour the bid in those situations. The existing empirical evidence on the impact on managerial ownership on bid outcome is inconclusive. Song and Walkling (1993) find that the level of managerial ownership is significantly related to the outcome of hostile bids but not to the outcome of friendly bids. Sudarsanam (1995) reports that although the managerial ownership is inversely related to the probability that a hostile bid will go through, the relationship is statistically insignificant.

Large shareholders' ownership (*LargeOwn*)

We measure the large shareholders' ownership as the percentage of target shares owned by the parties who have interest in 3% or more of the target shares. Under the UK Companies Act 1985, companies are required to disclose in their annual reports the ownership of anyone who has interest in 3% or more of equity shares. Thus, we obtain the data on large shareholders' ownership from the target firm's most recent annual report prior to the bid announcement.

The roles of large shareholders in takeover contests are widely documented but the direction of this variable on the merger outcome is indeterminate (Sudarsanam, 1995). In Shleifer and Vishny's (1986) model, the presence of the large shareholders in the target firms will increase the firm value and facilitate the takeovers. According to Gaspar et al. (2005), whether the large shareholders facilitate or deter takeovers is conditional on their investment horizon. In particular, short-term investors tend to sell their holdings and walk away, thereby speeding up the takeover; long-term investors, on the other hand, tend to exert their power on the negotiating table and contingent on the offer terms can hold out or facilitate the deal. A real-life example about the roles of larger shareholders relates to the bid for London Stock Exchange by Deutsche Borse. The bid failed because of the resistance from hedge funds and other funds, which at that time are large shareholders of LSE[19].

Method of payment *(Stock)*

This is a dummy variable which is equal to 1 if the offer is an equity offer and 0 otherwise. An equity offer may give rise to the problem of information asymmetry between the target and the bidder shareholders (Hansen, 1987). The target shareholders may assume that the bidder chooses to use equity offer only when the bidder's stock is overvalued. Therefore, an equity offer is more likely to trigger resistance or hard bargaining from target shareholders. The problem of information asymmetry associated with cash offers may be less serious. Furthermore, in the case of equity offers, the process of issuing equity often requires the approval of the bidder' shareholders. As a result, in stock mergers, approvals from both the bidder's and target's shareholders are required, whereas in cash mergers only approval from the target's shareholders is needed. In stock mergers, new stock issues may also require compliance with the stock exchange listing requirements and this may take time (Sudarsanam, 2010, ch18). Thus, cash offers might have higher chance of success than equity offers.

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[19] *"Deutsche Borse ponders bid for LSE" by* Tony Major and Alex Skorecki, Financial Times, 17 Jan 2003.

Toehold *(Toehold)*

Toehold is another name for the bidder's pre-bid share ownership in the target. We measure toehold as the percentage of the target equity shares owned by the bidder at the bid announcement date. Hirshleifer and Titman (1990) argue that acquiring toehold can help solve the free-rider problem in a value enhancing takeover bid and increase the chance the bid will go through. Furthermore, toehold reduces the number of shares that the bidder needs to acquire in order to gain control of the target. Given the toehold, the bidder can bid more aggressively by raising the bid premium as the additional premium is only paid for the shares acquired during the bid not on the toehold (Betton et al., 2009; Singh, 1998). In a multi-bidder contest, such aggressiveness would frustrate other rival bidders, thereby enhancing the probability of success for the initial bidder. Thus, it is expected that toehold has positive impact on the probability of bid success.

Sudarsanam (1996) notes that the benefits of toehold can be realized only when the bidder is able to accumulate sufficiently large toehold in anonymity. However, in the UK, it is not easy for the bidder to do so. Under the UK Companies Act 1989, acquisition of 3% or more of target shares must be notified within 2 business days. The Substantial Acquisition Rules of the City Code require acquisition of shares carrying voting rights of more than 15% and purchases of 1% or more of the shares above 15% but below 30% to be disclosed. Furthermore, under the City Code, acquisition of toehold that represents 30% or more of the target shares triggers a mandatory bid. Compared to a voluntary bid, a mandatory bid has a number of disadvantages. For example, in a mandatory bid, the offer must be cash or with cash alternatives at the highest price in the previous month and the offer cannot be subject to ' no material adverse change' (MAC) (see Sudarsanam (2010, ch18) for a thorough review of the mandatory bid's disadvantages).

Due to several disadvantages[20] of acquiring toehold in the UK context outlined above, toehold may have little impact on the probability that the bid goes through. Sudarsanam (1995; 1996) report only a weak association between the size of toehold and the takeover bids' success rates and the probability of bid success.

Irrevocable Undertaking *(Irrevocable)*

Irrevocable Undertaking is the percentage of the target equity shares that a shareholder or a group of shareholders of the target firm commit to tender to the bidder. The information about the irrevocable undertaking is disclosed in the offer document. For example, in its bid for Seet Plc on 21 March 2001, Cosalt Plc discloses in the offer document that it has received written irrevocable undertaking to accept the bid from the directors of Seet Plc and other shareholders in respect of 9.03 million shares representing 50.3% of the issued share capital of Seet Plc. The irrevocable commitment can offer benefits similar to toehold, that is, reduce the number of shares that the bidder needs to acquire and deter the entrance of rival bidders. And it can offer more. Wright et al (2007) argue that the irrevocable commitment is the result of the private negotiation process between the bidder and the management and the large shareholders of the target firm. As a result, irrevocable commitment sends a clear signal to the market that these informed investors approve the logic of the bid.

The irrevocable commitment not only can offer more benefits than toehold, but also can avoid the disadvantages associated with toehold. Obtaining irrevocable commitment triggers neither disclosure obligation nor a mandatory bid. As a result, it is expected that the larger the number of shares included in the irrevocable undertaking, the higher the chance that the bid is successful. To our best knowledge, this variable has not been used in any empirical tests about the factors influencing the bid outcome.

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[20] A discussion about the disadvantages of acquiring large toeholds in the US context is provided by Bris (2002) and Ravid and Spiegel (1999).

Scheme of Arrangement (*Scheme*)

This is a dummy variable which is equal to 1 if the bid is conducted via a scheme of arrangement and 0 otherwise. In the UK, the bidder can acquire the target via a general offer or a scheme of arrangement (Kenyon-Slade, 2004). In a general offer, the bidder makes a cash or stock offer to the target shareholders. This is the most popular form of conducting a takeover. In a scheme of arrangement, under Section 425-27 of the Companies Act 1985, an application is made to the court by the target firm in order for the court to direct meetings of relevant classes of shareholders. There are two reasons why a takeover conducted via a scheme of arrangement has higher chance of success. First, as the application for the scheme must be made by the target, the deal is always a friendly one. Second, in the scheme, the bidder can secure 100% ownership of target's shares if it obtains the approval for the scheme from the target shareholders representing 75% of the total share ownership of those shareholders who are present and vote at the meeting. In case of a general offer, the bidder can be sure that it can own all the target's shares only when it acquires 90% of the share ownership of all target's shareholders not just the ones present at the meeting. Thus, the freeze-out threshold is considerably lower with a scheme of arrangement. Takeovers conducted via a scheme of arrangement have become increasingly popular in recent years in the UK (Sudarsanam, 2010, ch18).

Termination fee (*Termination*)

This is dummy variable, which is equal to 1 if the target agrees to pay the bidder a termination fee and 0 otherwise. A target termination fee, or inducement fee[21], clause requires the target firm to pay a fixed cash sum to the bidder if specified events occur which have the effects of preventing the bid from proceeding or causing it to fail. As a typical example of such specified events, the target management recommend a higher competing bid. With a US sample of 2511 takeover bids from 1988 to 2000, Officer (2003) find that the inclusion of the termination fee term is associated with

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[21] The term 'inducement fee' is used in the UK Takeover Code but it has the same meaning as the term 'termination fee' or 'breakup fee' used in the US context. See Kenyon-Slade (2004, p631) for more detail.

approximately 4% higher bid premium and increases the likelihood that the bid is successfully completed by almost 20%. In the UK, under Rule 21.2 of the City Code, the termination fee is capped at 1% of the offer value, while in Officer (2003) study, the average termination fee is equal 3.8% of the offer value. Thus, in the UK context, the impact of termination fee clause on the bid outcome is expected to be less pronounced than in the US context.

Target size ($TargetSize$)

We measure the target size as the market value of the target equity at the bid announcement in GBP 2007. The probability of a successful bid may decrease with target size for two reasons. First, bidder may find it more difficult to obtain sufficient funds to finance a large takeover bid. Consequently, the bidder is forced to offer a small premium, thereby lowering the chance that the bid can go through. Second, in a horizontal merger, a large deal is more likely to trigger regulatory concern about anti-trust issue. Next, we discuss the anti-trust risk in more detail.

Anti-trust risk proxies

Anti-trust risk refers to the risk that the bid is blocked by the regulatory authority due to the concern that the merger may lead to a *'substantial lessening of competition'*(SLC) (Sudarsanam, 2010, ch17). In the UK, the merger investigation is a two-stage process[22]. The first stage is the preliminary screening by the Office of Fair Trading (OFT). If the OFT identifies the merger might lead to SLC, it refers this qualifying merger to the Competition Commission (CC) for more detailed investigation. Once the OFT makes a reference to the CC, the bid lapses. Hence, the regulatory risk is the uncertainty about the OFT referral.

[22] See Kryda (2002), Arnold and Parker (2007; 2009) and Sudarsanam (2010, ch17) for a thorough review of the investigation process.

Whether the mergers are qualified to be investigated by the OFT is defined under the UK competition laws. In general, the mergers are qualified when one of the two tests is satisfied (Arnold and Parker, 2007). First, the target's total asset is greater than £70 million. Second, the combined market share of the bidder and the target is more than 25%. The second test is more likely to be satisfied if the merging firm are related, i.e. they are in the same industry, than if they are unrelated.

Thus, if a takeover bid involves a target, whose total asset is greater than £70 million, or the bidder and the target are related, the chance that it will be referred by the OFT to the CC is higher than other bids. Based on this argument, we construct the two variables namely $SizeTest$ and $Relatedness$ as the proxy for anti-trust risk. $SizeTest$ is a dummy variable which is equal to 1 if the target' total asset at the bid announcement date is greater than £70 million and 0 otherwise. $Relatedness$ is a dummy variable which is equal to 1 if the bidder and the target share the same 3-digit Standard Industrial Classification (SIC) code. The SIC code is obtained from Thomson online SDC. Since market definitions used by the OFT and the CC are generally narrow, a 3-digit SIC code is a better classification than a 2-digit SIC code (Sudarsanam, 2010, ch17). These two variables represent the two tests for qualifying mergers discussed in the previous paragraph.

Although it is important to control for anti-trust risk in the bid outcome model, the risk may be quite low in the UK. According to Sudarsanam (2010, ch17), the UK antitrust regime is more predictable and more time bound than the US regime. The referral rates and the rejection rates are quite low. In Arnold and Parker's (2007) study, out of 9872 UK mergers from 1989 to 2002, only 156 cases are referred to the CC (around 1.6%). Among these 156 referral cases, 61 cases proceed without any remedy. Furthermore, the UK anti-trust regime does not generally involve the courts although after the Enterprise Act 2002, the parties can appeal the CC decision to the Competition Appeal Tribunal (CAT). All of these characteristics of the antitrust regime in the UK indicate that anti-trust risk might have only a small impact on the probability of bid success.

All variables in the model to predict the probability of bid success are summarized in Table 3.2.

[Insert Table 3.2, page 84 here]

3.4.2 Model result

As the bid outcome model plays an important role in both second and third empirical project testing the limited arbitrage hypothesis and the arbitrageurs' role hypothesis, to avoid repetition, we discuss the result of the model estimation in this chapter. We use the same sample of takeover bids as the second and the third project. The sample selection process is described in section 3.2.2. The sample includes 653 UK cash and stock takeover bids from 1997 to 2007.

Data on almost all of the variables used in the bid outcome model are obtained from Thomson on-line SDC. Data on the market value of the target equity are downloaded from Datastream. Data on managerial ownership and large shareholders' ownership are manually collected from the target's most recent annual report prior to the bid announcement date. The annual reports are obtained from Perfect Filings.

Descriptive statistics and univariate analysis

Table 3.3 and Table 3.4 present the descriptive statistics of the variables used in the bid outcome model for the whole sample, for the subsamples of successful bids versus unsuccessful bid (Table 3.3) and for the subsamples of cash bids versus stock bids (Table 3.4).

[Insert Table 3.3, page 86 here]

[Insert Table 3.4, page 87 here]

Based on the statistical tests of the difference in mean and median of the variables between the subsamples, several interesting patterns can be observed. The mood of the offer appears to be one of the most important determinants of the bid outcome. Nearly of 30% of the failed bids are hostile whereas the figure is only 3.6% for successful bids. The proportion of hostile bids in the subsample of cash bids is significantly lower than in the subsample of stock bids. This explains the lower success rate of stock bids versus cash bids as well as the lower proportion of stock bids in the subsample of successful bids versus the subsample of failed bids.

As target management attitude toward the bid seems to have such a powerful influence on the bid outcome, the target's managerial ownership is expected to have a similar impact. The result in Table 3.3 validates this expectation. Managerial ownership of the successful bids (11.73% of target shares) is significantly greater than that of failed bids (5.57%). There is no sizable difference in managerial ownership between cash bids and stock bids.

While managerial ownership has significant impact on the bid outcome, there is little evidence about the impact of large shareholders' ownership. The average large shareholders' ownership is around 38% of target shares for the whole sample and is about the same for the subsample of successful bids and the subsample of failed bids. There is no sizable difference in large shareholders' ownership between the subsample of cash bids and the subsample of stock bids.

Whether the bid has multiple bidders does not seem to affect the outcome of the bid. There is no discernable difference in the proportion of bids with multiple bidders between the subsamples of unsuccessful bids and failed bids. This result, however, should be subject to doubt. As we argued in the previous section, from the arbitrageurs' perspective, the multi-bidder situation affects the outcome of cash bids and the outcome of stock bids in opposite ways. While the multi-bidder situation increases the likelihood of a successful cash bid, it decreases the chance that a stock is consummated successfully. Thus, the insignificant result may stem from the lack of controlling for the bid's method of payment. The proportion of cash bids with multiple bidders (16.89%) is more than double the proportion of stock bids with multiple bidders (7.94%) and the difference is statistical significant at 1% level. Thus, cash appears to be the bidders' preferred method of payment to win a bidding war.

As for toehold and irrevocable undertaking, the size of the former (4.57% of the target shares) is too modest compare to the size of the latter (16.55%) of the target shares. While toehold does not have any influence on the bid outcome, the irrevocable undertaking does. There is no difference in the level of toehold between successful bids and failed bids, whereas the percentage of target shares that are irrevocably committed in successful bids is about 6 times larger than the figure in failed bids (18.17% versus 3.21%). This result is consistent with the argument in section 3.4.1 about the disadvantages of large toeholds and the advantages of irrevocable undertaking compared to toehold. Large toeholds trigger disclosure obligation and a mandatory bid with its disadvantages compared to a voluntary bids. Irrevocable commitment has no such disadvantages. Furthermore, as irrevocable commitment is often made by informed investors after a private negotiation process (Wright et al., 2007) and it make sense for the bidder to negotiate mainly with the large shareholders, the size of irrevocable commitment should be much larger than the size of toehold. And this is actually the case in our sample. As far as the method of payment is concerned, the level of both toehold and irrevocable undertaking is both greater in cash bids than in stock bids.

The statistics show that if the bid is conducted via a scheme of arrangement or the target agrees to pay the bidder a termination fee, the likelihood that the bid succeeds is higher. The proportion of bids conducted via a scheme of arrangement (10.82%) or having termination fee clause (11.34%) is significantly larger in the subsample of successful bids than in the subsample of failed bids (5.63% and 4.23% respectively). This result is consistent with the argument in section 3.4.1. The proportion of cash bids with termination fee is greater than the proportion of stock bids. There is no difference between the proportion of cash bids conducted via a scheme of arrangement and the proportion of stock bids conducted via a scheme of arrangement.

Finally, in contrast to our argument in section 3.4.1, anti-trust risk appears to be a powerful hindrance to bid success. The average size of the target equity market value and the proportion of bids, in which either the target's total asset is more than £70 million or both the bidder and the target share the same 3-digit SIC code, are significantly higher in the subsample of failed bids than in the subsample of successful bids. No discernable difference in average size of the target equity market value and in the proportions of bids, in which the target's total asset is greater than £70 million between the subsample of cash bids and the subsample of stock bids is observed. The proportion of bids, in which both the bidder and target share the same 3-digit SIC code, is significantly lower in the subsample of cash bids than in the subsample of stock bids. Thus, stock bids are more likely to face anti-trust risk, which explains why stock bids have lower success rates.

To sum up, when each variable in the bid outcome model is considered independently, the following variable appears to have no impact on the outcome of a takeover bid: whether the bid has multiple bidders, large shareholders ownership, and toehold. The probability of bid success is significantly reduced when the bid is hostile or due to anti-trust investigation i.e. bids with large target and bids where the bidder and the target are related. The chance that the bid is consummated increases when the bid is conducted via a scheme of arrangement, has higher level of irrevocable undertaking, has a termination fee clause, and has higher level of managerial ownership. In the next section, we examine the result in the multivariate context when the impacts of all these variables are considered together.

<u>**Logistic regression result**</u>

Table 3.5 presents the result of the logistic regression that estiamtes the probability of bid success. Since we define bid outcome differently for cash bids and stock bids, we also re-estimate the logit model for the subsamples of cash bids and stock bids. The results for these subsamples are reported in Table 3.6 and Table 3.7. Alongside the coefficient estimates and their standard errors, we also report the odds ratio associated with each vaiable.

[Insert Table 3.5, page 88 here]

[Insert Table 3.6, page 90 here]

[Insert Table 3.7, page 91 here]

The result of the logistic regression is generally consistent with the univariate result discussed earlier in this section and the extant literature discussed in Section 3.4.1. The mood of the offer continues to be one of the most important determinants of the bid outcome. The chance that the bid is consummated is significantly reduced when the target managment resists the offer. The odd that a hostile bid is successful is 0.14 (model (1) in Table 3.5) indicating that the probablity of sucess for hostile bids is equal to 0.14 multiplied by the probability of success for friendly bids. In other words, the probablity that a hostile bid succeeds is 7 times lower than probabiliy of success of a friendly bid. The impact of the mood of the offer on bid outcome also holds for the subsamples of cash bids and stock bids.

The presence of rival bidders first appears to have no impact on the probability of bid success (model (1) Table 3.5). As we noted in the univariate analysis, this result may stem from the fact that the multi-bidder situation affects the outcome of stock bids and cash bids in opposite ways. To take into account the difference between cash bids and stock bids, we replace the variables $MultiBidders$ with two interaction terms $MultiBidders \times Stock$ and $Multibidders \times Cash$, where $Stock$ ($Cash$) is a dummy variables which are equal to 1 if the bidder offers stock (cash) in exchange for the target shares and 0 otherwise. The first interaction term represents the impact of the multi-bidder sistuation on the probability of bid success when the bid is a stock bid and the second term represents the impact when the bid is a cash bid.

The coefficient estimates of these two interaction terms are statistically signficant at 1% in model (2) –(5) of Table 3.5. As expected, for stock bids, the presence of rival bidders reduces the chance that the bid is successful. From the odds ratio, it can be inferred that the probability of success is, on average, around 14 times lower for a stock bid with two or more bidders than for a stock bid with a single bidder. From the arbitrageurs' perspective, a stock bid is successful only when the initial bidder win the competition. This result remains the same for the subsample of stock bids (Table 3.7). For cash bids, the impact of mult-bidder situation is opposite. As the emergence of rival bidders increases the chance that the target will eventually be acquired by one of the competitors, from the arbitrageurs' perspective, the likelihood that a cash bid is consummated improves with multi-bidder situation. The odd that a cash bid with two or more bidders succeeds is 4.5 times greater than the odd for cash bid with only one bidder. This result is similar for the subsample of cash bids (Table 3.6).

Toehold and the percentage of target shares irrecovably committed both contribute positively to the probability of success. The finding is similar to Betton et al. (2009). In this sample, the impact of irrevocable commitment on the probability of bid success dominates the impact of toehold as only the former is statistically significant. This result is consistent with the argument in Section 3.4.1 about the advantages of irrevocable commitment over toehold and with the result of the univariate analysis.

Similar to the result of the univariate analysis, whether the bid is conducted via a scheme of arrangement significantly increases the chance that the bid will go through. The probability of success is around 2.8 times higher for bids conducted via a scheme of arrange than for other bids. This may help explain why scheme of arrangement has become increasingly popular in the UK over the last couple of years (Sudarsanam, 2010, ch18).

Managerial ownership, large shareholders' ownership and whether the bid has a termination fee clause do not appear to have any impact on the probability of bid success. For large shareholders' ownership, this result is similar to the univariate analysis, in which there is no difference in the level of large shareholders' ownership between successful bids and failed bids. For the other two variables, although both can significantly affect the bid outcome when considered independently, their impact on bid outcome disappears when considered concurrently with other variables. This is because these variables are correlated with other variables in the model and when considered with other variables they have no incremental explanatory power. In our sample, managerial ownership is negatively correlated to the size of the target. When we remove the two variables that proxy for size, i.e. the target equity market value ($TargetSize$) and whether the target's total asset is greater than £70 million ($SizeTest$), managerial ownership becomes significant at 10% level (model (6) of Table 3.5). As for termination fee, the variable is also become significant at 10% level when the mood of the offer, method of payment, scheme of arrangement and irrevocable undertaking are removed from the logistic regression (model (7) of Table 3.5).

Finally, consistent with the univariate result, the probability of bid success decreases significantly for bids which are more likely to be subject to anti-trust regulation. The target equity market value is negatively related to the probability of bid success and the relationship is statistically significant at 5% level. The variable $SizeTest$, which is an indicator of whether the target's total asset is greater than £70 million, is not significant when the target equity market value is included in the logistic regression because both variables proxy for the size of the target. When the target equity market value is removed, $SizeTest$ becomes statistically significant (model (4) of Table 3.5). From the odds ratio, it can be inferred that the probability of success of bids with the target's total assets greater than £70 million is around 2 times lower than the probability of success of the other bids. When the bidder and the target are related (share the same 3-digit SIC code), the chance the bid goes through is significantly tampered.

In summary, in the multivariate analysis, we find that when other variables are taken into account, toehold, managerial ownership, large shareholders' ownership and whether the bid has termination fee clause have no impact on the probability of bid success. The probability of bid success is significantly reduced when the bid is hostile or is more likely to face anti-trust investigation. From the arbitrageurs' perspective, a cash bid is more likely to go through if more than one bidder are competing to acquire the target. The opposite is true for stock bids. The chance of success improves if the bidders can obtain high level of irrevocable commitment, or the bid is conducted via a scheme of arrangement.

3.5 Chapter summary

This chapter outlines the data and the methodology issues that are common to three empirical projects designed to tackle the research question of this doctoral study. Three data sources are employed: Thomson online SDC, Datastream, and Perfect Filings. Two samples of takeover bids are used for the empirical analysis. The first empirical project testing the risk-based hypothesis employs the first sample of 1105 UK cash and stock takeover bids from 1987 to 2007. The second sample is for the second and third project testing the limited arbitrage hypothesis and the arbitrageurs' role hypothesis respectively. Due to additional data requirements in the second and third project, the second sample is indeed a subsample of the first sample. The second sample includes 653 UK cash and stock takeover bids from 1997 to 2007

As each empirical project employs different methodology, it is better to discuss the methodology in detail when the empirical projects are conducted. In this chapter, only two common methodological issues are discussed. As the aim of this study is to identify and test the factors that contribute to the source of the return to the merger arbitrage strategy, the first common issue is the method to calculate arbitrage return. Since one of the key tasks for arbitrageurs is to estimate the probability that the bid can go through, the second common issue is to develop a model predicting the outcome of the bid. Because the model plays an important role in the second and third project, to avoid repetition, we not only describe the model but also use the second sample of takeover bids to estimate the model and discuss the result.

To estimate the probability of bid success, we employ the logistic regression model, in which the dependent variable is the bid outcome indicator variable which is equal to 1 if the bid is successful and 0 otherwise. From the arbitrageurs' perspective, a cash bid succeeds when the target is acquired [by one of the bidders]; a stock bid is successful when the bidder, whose stocks are shorted by the arbitrageurs, acquires the target. The independent variables are the characteristics of the bid, the bidder and the target that can be observed at the bid announcement date. Among these variables, toehold, managerial ownership, large shareholders' ownership are found to have no impact on the bid outcome. Hostile bids, bids that are likely to be investigated by anti-trust authority i.e. bids with large target or bidder and target are related, and stock bids with more than one bidder have lower probability of success. The likelihood that a bid is consummated increases when the bidder obtains high level of irrevocable commitment or the bid is conducted via a scheme of arrangement or a cash bid has more than one bidder.

In the next chapter, we perform the first empirical project in the journey to answer the research question:' *' What is the magnitude of merger arbitrage return in the UK market and what are the factors that determine the return?'*. The project tests the risk-based hypothesis in the UK context.

Table 3.1: Summary of the takeover bid sample selection process

Sample Selection Process	Database	Number of observations discarded	Sample size
Initial sample of takeover bids - The bidder is seeking to control more than 50% of the target shares. - The bid announcement date is from 01/01/1997 to 31/12/2007 - The bid's consideration structure is either pure cash or pure stock - For cash bids, the target must be a public company listed on a UK stock exchange; for stock bids, both bidder and target are required to be publicly traded companies	Thomson online SDC		1392
Rumours or bidder's intention	Thomson online SDC	38	1354
Missing announcement or resolution date	Thomson online SDC	97	1257

Sample Selection Process	*Database*	**Number of observations discarded**	**Sample size**
Announcement date are the same as resolution date	Thomson online SDC	89	1168
Data about share price and market value over the offer period are available from Datastream for the target firm in case of cash bids and for both target and bidder firm in case of stock bids	Datastream	63	1105
Sample for risk-based hypothesis			**1105**
The bid announcement date is from 01/01/1997 to 31/12/2007	Thomson online SDC	304	801
The bid duration, which is the number of days between the announcement date and the resolution date, is at least 21 days	Thomson online SDC	56	745
Data about the total return index on the target stocks are available in Datastream for the period starting 160 days prior to the bid announcement date and ending at the bid resolution date	Datastream	49	696
Data about the target firm are available in Perfect Filings	Perfect Filings	43	653
Sample for limited arbitrage hypothesis and arbitrageurs' role hypothesis			**653**

Table 3.2: Description of the variables in the bid outcome model

Variable name	Description	Data source
Outcome	*Outcome* is the bid outcome indicator variable, which is equal to 1 if the bid is successful and 0 otherwise. A cash bid is considered to be successful when the target is acquired. A stock bid is considered to be successful when the bidder, whose stocks are shorted by the arbitrageurs, acquires the target.	SDC
Hostile	*Hostile* is a dummy variable which is equal to 1 if the bid is hostile and 0 otherwise. Hostile measures the mood of the offer.	SDC
MultiBidders	*MultiBidders* is a dummy variable which is equal to 1 if two or more bidders are competing to takeover one target and 0 otherwise.	SDC
ManOwn	*ManOwn* is the managerial ownership measured as the percentage of target share directly owned by the target managers and their family. Managerial ownership is obtained from the target firm's most recent annual report prior to the bid announcement.	Perfect Filings (Annual reports)
LargeOwn	*LargeOwn* is the large shareholders' ownership measured as the percentage of target shares owned by the parties who have interest in 3% or more of the target shares. Large shareholders' ownership is obtained from the target firm's most recent annual report prior to the bid announcement.	Perfect Filings (Annual reports)
Stock	*Stock* is a dummy variable which is equal to 1 if the bidder stocks are used to pay for the target stocks and 0 otherwise. This variable represents the bid's method of payment	SDC
Toehold	*Toehold* is the percentage of target shares owned by the bidder at the bid announcement date	SDC
Irrevocable	*Irrevocable* is the percentage of target shares that a shareholder or a group of shareholders of the	SDC

Variable name	Description	Data source
	target firm commit to tender to the bidder	
Scheme	*Scheme* is a dummy variable which is equal to 1 if the bid is conducted via a scheme of arrangement and 0 otherwise.	SDC
Termination	*Termination* is a dummy variable which is equal to 1 if the target agrees to pay the bidder the termination fee and 0 otherwise	SDC
TargetSize	*TargetSize* is the market value of target equity at the bid announcement date in 2007 GBP. The *UK Consumer Price Index – All Urban: All items* is used to convert target size to 2007 value.	Datastream
SizeTest	*SizeTest* is a dummy variable which is equal to 1 if the target's total asset at the bid announcement date is more than £70 million and 0 otherwise.	SDC
Relatedness	*Relatedness* is a dummy variable which is equal to 1 if the bidder and the target share the same 3-digit SIC code and 0 otherwise.	SDC

Table 3.3: Descriptive statistics of the bid outcome model variables categorized by bid outcome

This table presents the descriptive statistics of the bid outcome model variables for the whole sample and for the subsamples of successful and unsuccessful bids. All variables are defined in Table 3.2. The result of the tests for the difference in mean and median between these two subsamples is also reported

Variable	All	Success (N= 582)	Failure (N=71)	Difference
	Mean [Median]	Mean [Median]	Mean [Median]	Mean [Median]
Managerial Ownership	11.06%	11.73%	5.57%	6.16%***
	[3.23%]	[3.84%]	[0.54%]	[3.3%]***
Large shareholders' ownership	38.5%	38.75%	36.49%	2.25%
	[39.65%]	[39.81%]	[35.55%]	[4.26%]
% of stock bids	19.3%	17.18%	36.62%	-19.44%***
% having termination fee	10.57%	11.34%	4.23%	7.11%***
% with multiple bidders	15.16%	14.95%	16.9%	-1.95%
% of hostile bids	6.43%	3.61%	29.58%	-25.97%***
% with scheme of arrangement	10.26%	10.82%	5.63%	5.19%**
% with target's total asset > £70	47.63%	44.85%	70.42%	-25.58%***
% with the same 3-digit SIC code	27.72%	26.29%	39.44%	-13.15%***
Toehold	4.57%	4.56%	4.6%	-0.03%
	[0%]	[0%]	[0%]	[0%]
Irrevocable Undertaking	16.55%	18.17%	3.21%	14.96%***
	[0%]	[0.34%]	[0%]	[0.34%]***
Target size (£2007)	377.6529	330.5816	763.5051	-432.9235
	[59.1347]	[52.9689]	[168.8929]	[-115.9241]

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 3.4: Descriptive statistics of the bid outcome model variables categorized by method of payment

This table presents the descriptive statistics of the bid outcome model variables for the whole sample and for the subsamples of cash and stock bids. All variables are defined in Table 3.2. The result of the tests for the difference in mean and median between these two subsamples is also reported

Variable	All	Cash Bids (N= 527)	Stock Bids (N=126)	Difference
	Mean [Median]	Mean [Median]	Mean [Median]	Mean [Median]
Managerial Ownership	11.06%	11.28%	10.13%	1.15%
	[3.23%]	[3.13%]	[3.86%]	[-0.73%]
Large shareholders' ownership	38.5%	38.53%	38.4%	0.13%
	[39.65%]	[39.7%]	[37.62%]	[2.08%]
% of successful bids	19.3%	91.46%	79.37%	12.1%***
% having termination fee	10.57%	12.33%	3.17%	9.16%***
% with multiple bidders	15.16%	16.89%	7.94%	8.95%***
% of hostile bids	6.43%	5.5%	10.32%	-4.81%***
% with scheme of arrangement	10.26%	10.06%	11.11%	-1.05%
% with target's total asset > £70	47.63%	47.82%	46.83%	0.99%
% with the same 3-digit SIC code	27.72%	24.29%	42.06%	-17.78%***
Toehold	4.57%	4.85%	3.38%	1.47%*
	[0%]	[0%]	[0%]	[0%]
Irrevocable Undertaking	16.55%	17.26%	13.56%	3.7%**
	[0%]	[0%]	[0%]	[0%]*
Target size (£2007)	377.6529	373.1808	396.3579	-23.1771
	[59.1347]	[62.4100]	[47.5876]	[14.8224]

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 3.5: Logistic regression result of the bid outcome model – Full sample

This table presents the result of the logistic regression employed to estimate the probability of bid success on the full sample of 653 UK takeover bids from 1997 to 2007. All variables except for *Cash* are described in Table 3.2. *Cash* is a dummy variable which is equal to 1 if the bidder offers cash to pay for the target stock and 0 otherwise. For each variable, the first row shows the coefficient estimate; the second row shows the odd ratio; the third row shows the heteroskedasticity-consistent standard errors of the coefficient estimates.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	3.9817***	3.5981***	3.6397***	2.1070***	1.3949***	1.3939***	3.0947***
	na	na	na	na	na	na	na
	(0.8444)	(0.8529)	(0.8457)	(0.5359)	(0.4245)	(0.4242)	(0.7327)
LargeOwn	-0.6913	-0.3109	-0.3246	0.5171	0.8702	0.9577	0.7033
	0.5009	0.7328	0.7228	1.6771	2.3875	2.6058	2.0204
	(0.8657)	(0.8874)	(0.8854)	(0.7957)	(0.7680)	(0.7597)	(0.7835)
ManOwn	0.1590	0.2389	0.2929	1.4231	2.1925	2.5373*	2.4287*
	1.1530	1.2698	1.3404	4.1498	8.9580	12.6461	11.3447
	(1.4343)	(1.4551)	(1.4478)	(1.4133)	(1.3592)	(1.3599)	(1.3652)
Hostile	-1.9845***	-1.8533***	-1.8573***	-1.8175***	-1.7896***	-1.8306***	
	0.1375	0.1567	0.1561	0.1624	0.1670	0.1603	
	(0.3870)	(0.4088)	(0.4088)	(0.4013)	(0.3946)	(0.3985)	
MultiBidders	0.4250						
	1.5296						
	(0.3968)						
MultiBidders x Cash		1.5102***	1.5259***	1.3210**	1.2602**	1.2593**	1.5517***
		4.5276	4.5991	3,7472	3.5261	3.5228	4.7193
		(0.5831)	(0.5826)	(0.5708)	(0.5659)	(0.5657)	(0.5574)
Multibiddersx Stock		-2.6933***	-2.6916***	-2.8438***	-2.9154***	-2.8992***	-3.1472***
		0.0677	0.0678	0.0582	0.0542	0.0551	0.0430
		(1.0416)	(1.0429)	(1.0308)	(1.0235)	(1.0353)	(0.8270)
Toehold	0.6409	1.2011	1.1694	1.7118	1.7810	1.8529	0.0320
	1.8981	3.3237	3.2200	5.5390	5.9358	6.3783	1.0325
	(1.3547)	(1.3935)	(1.3906)	(1.3663)	(1.3406)	(1.3508)	(1.2763)
Irrevocable	4.4657***	4.5045***	4.4999***	4.6555***	4.6641***	4.7054***	
	86.9797	90.4224	90.0086	105.1630	106.0706	110.5426	
	(1.3118)	(1.2704)	(1.2677)	(1.2894)	(1.2831)	(1.2827)	
Scheme	1.0426*	1.0012*	1.0026*	0.8781	0.8165	0.8029	
	2.8367	2.7216	2.7254	2.4063	2.2626	2.2321	
	(0.5841)	(0.5888)	(0.5902)	(0.5753)	(0.5720)	(0.5748)	
Stock	-0.8605***	-0.3855	-0.3764	-0.3266	-0.2520	-0.2457	
	0.4229	0.6801	0.6863	0.7214	0.7773	0.7821	
	(0.3185)	(0.3513)	(0.3501)	(0.3479)	(0.3434)	(0.3429)	

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 3.5: Continued...

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Termination	0.2217	0.2092	0.2163	0.2107	0.2594	0.2252	1.1051*
	1.2482	1.2327	1.2414	1.2345	1.2962	1.2525	3.0194
	(0.6527)	(0.6546)	(0.6536)	(0.6551)	(0.6504)	(0.6479)	(0.6219)
ln(TargetSize)	-0.2931**	-0.3065**	-0.3374***				-0.2837**
	0.7460	0.7360	0.7136				0.7530
	(0.1232)	(0.1276)	(0.1038)				(0.1166)
SizeTest	-0.2393	-0.1732		-0.7709**			-0.2728
	0.7872	0.8410		0.4626			0.7612
	(0.4003)	(0.4167)		(0.3309)			(0.3817)
Relatedness	-0.6056**	-0.5162	-0.5229	-0.5402*		-0.5814*	-0.3765
	0.5457	0.5968	0.5928	0.5826		0.5591	0.6862
	(0.3076)	(0.3195)	(0.3186)	(0.3172)		(0.3121)	(0.2878)
SizeTest x Relatedness					-0.6890*		
					0.5021		
					(0.3575)		
(Pseudo) R^2	0.2292	0.2656	0.2652	0.2524	0.2401	0.2398	0.1543

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 3.6: Logistic regression result of the bid outcome model – Cash sample

This table presents the result of the logistic regression employed to estimate the probability of bid success on the sample of 527 UK cash bids from 1997 to 2007. All variables are described in Table 3.2. For each variable, the first row shows the coefficient estimate; the second row shows the odd ratio; the third row shows the heteroskedasticity-consistent standard errors of the coefficient estimates.

Model	(1)	(2)	(3)	(4)
Intercept	3.7352***	3.6671***	1.6153***	0.9856**
	na	na	na	na
	(1.0204)	(1.0181)	(0.6211)	(0.4740)
LargeOwn	-0.4602	-0.4402	0.7623	1.0715
	0.6311	0.6439	2.1432	2.9198
	(1.0673)	(1.0707)	(0.9391)	(0.9079)
ManOwn	1.9333	1.8376	3.9046*	4.6417**
	6.9123	6.2813	49.6289	103.7230
	(2.0706)	(2.0652)	(2.0806)	(1.9976)
Hostile	-1.3083***	-1.3085***	-1.3421***	-1.3484***
	0.2703	0.2702	0.2613	0.2597
	(0.4915)	(0.4895)	(0.4699)	(0.4643)
MultiBidders	1.7486***	1.7166***	1.4574**	1.4154**
	5.7466	5.5654	4.2948	4.1183
	(0.5952)	(0.5904)	(0.5715)	(0.5674)
Toehold	0.8267	0.8898	1.4232	1.4420
	2.2857	2.4346	4.1503	4.2293
	(1.4787)	(1.4757)	(1.4249)	(1.4014)
Irrevocable	7.3379***	7.3096***	7.4600***	7.4879***
	153.7459	149.4598	173.7172	178.6244
	(2.4320)	(2.4509)	(2.5125)	(2.4931)
Scheme	0.8349	0.8315	0.6253	0.5685
	2.3046	2.2967	1.8688	1.7657
	(0.6719)	(0.6703)	(0.6621)	(0.6595)
Termination	1.3030	1.2847	1.2808	1.3114
	3.6801	3.6137	3.5997	3.7112
	(1.0669)	(1.0672)	(1.0684)	(1.0657)
ln(TargetSize)	-0.4455***	-0.3908***		
	0.6405	0.6765		
	(0.1575)	(0.1255)		
SizeTest	0.3069		-0.6405	
	1.3592		0.5270	
	(0.5310)		(0.4043)	
Relatedness	-0.5980	-0.6057	-0.6338*	
	0.5499	0.5457	0.5306	
	(0.3879)	(0.3880)	(0.3832)	
SizeTest x Relatedness				-0.6655
				0.5140
				(0.4539)
(Pseudo) R^2	0.2570	0.2560	0.2297	0.2199

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 3.7: Logistic regression result of the bid outcome model – Stock Sample

This table presents the result of the logistic regression employed to estimate the probability of bid success on the sample of 126 UK stock bids from 1997 to 2007. All variables are described in Table 3.2. For each variable, the first row shows the coefficient estimate; the second row shows the odd ratio; the third row shows the heteroskedasticity-consistent standard errors of the coefficient estimates.

Model	(1)	(2)	(3)	(4)
Intercept	2.4615	2.6507	2.4872**	1.8051**
	na	na	na	na
	(1.6597)	(1.6535)	(1.0846)	(0.9069)
LargeOwn	0.4099	0.4308	0.3971	0.7663
	1.5067	1.5384	1.4874	2.1518
	(1.8155)	(1.8215)	(1.7041)	(1.6443)
ManOwn	-1.7252	-1.4638	-1.7453	-1.3703
	0.1781	0.2313	0.1746	0.2540
	(2.4538)	(2.3987)	(2.2485)	(2.1714)
Hostile	-3.1874***	-3.2231***	-3.1906***	-2.9623***
	0.0413	0.0398	0.0411	0.0517
	(0.9415)	(0.9322)	(0.9285)	(0.8631)
MultiBidders	-3.1553***	-3.1011***	-3.1510***	-3.2408***
	0.0426	0.0450	0.0428	0.0391
	(1.0813)	(1.0555)	(1.0602)	(1.0550)
Toehold	4.3097	4.9323	4.2881	5.0134
	74.4163	138.6932	72.8267	150.4202
	(4.6378)	(4.7250)	(4.5147)	(4.3858)
Irrevocable	2.7638	2.3760	2.7577	2.7651
	15.8597	10.7617	15.7634	15.8808
	(1.7555)	(1.6574)	(1.7288)	(1.6929)
Scheme	2.0264	1.9832	2.0297	1.8882
	7.5866	7.2659	7.6114	6.6077
	(1.6290)	(1.5912)	(1.6226)	(1.5248)
Termination	-3.2663**	-3.1076**	-3.2608**	-3.1231**
	0.0381	0.0447	0.0384	0.0440
	(1.5716)	(1.4848)	(1.5475)	(1.4761)
ln(TargetSize)	0.0052	-0.1225		
	1.0052	0.8847		
	(0.2560)	(0.2182)		
SizeTest	-0.7962		-0.7884	
	0.4510		0.4546	
	(0.7864)		(0.6880)	
Relatedness	-0.5908	-0.7340	-0.5901	
	0.5539	0.4800	0.5543	
	(0.6389)	(0.6243)	(0.6382)	
SizeTest x Relatedness				-0.7599
				0.4677
				(0.6408)
(Pseudo) R^2	0.3717	0.3636	0.3717	0.3589

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Chapter 4: RISK-BASED HYPOTHESIS

4.1 Introduction

In this chapter, we examine how the risk-based hypothesis helps explain the source of the merger arbitrage return. Under the setting of a perfect capital market, the theoretical argument in Chapter 2 has shown that the systematic risk specified in a correct asset pricing model is the sole determinant of the return to the strategy. The risk-based hypothesis is the logical starting point to tackle the research question: *"What is the magnitude of merger arbitrage return in the UK market and what are the factors that determine the return?"* for two reasons.

First, to address the part of the research question about the profitability of the merger arbitrage strategy, we cannot ignore risk. One of the factors that make the research about merger arbitrage particularly interesting is that the strategy can generate substantial positive return on a risk-adjusted basis not just the raw return. Risk plays an important role in evaluating the profitability of any investment strategy. Though an investment strategy can generate a huge return, it is not necessarily profitable if it bears too much risk.

Second, though there is ample evidence about the magnitude of the risk-adjusted return in the US market, the evidence outside the US is relatively scant. To our best knowledge, there is no evidence for the UK market, the one in which this project focuses on. Thus, it is interesting to see whether the strategy can generate positive risk-adjusted return in the UK market. Further, as the discussion in Chapter 2 shows, the other two hypotheses namely the limited arbitrage hypothesis and the arbitrageurs' role hypothesis, are proposed to explore what lie behind the existence of the abnormal return, the part of the merger arbitrage return that is unexplained by sytematic risk. Thus, it is futile to pursue the other two hypotheses without the knowledge of about whether the strategy can generate abnormal return in the UK market.

In addition to examining the extent to which risk can help shed light on the source of the return to the strategy, this chapter is also aimed at exploring the impact of the UK takeover regulations on the risk-return characteristics of the strategy. For the US market, Mitchell and Pulvino (2001) find that the return to the strategy is related to the market risk in a non-linear way. However, Maheswaran and Yeoh (2005) do not find such pattern in the Australian market. Although these studies report the different empirical results, they do not go far enough to uncover the reasons underlying the difference. In this chapter, we make an inquiry into the difference and postulate that the difference in the risk-return pattern of the strategy in different markets may be attributable to the difference in the takeover regulations. We establish the hypothesis based on such inquiry and perform empirical tests.

The chapter is structured as following. Section 4.2 develops the hypotheses for the empirical tests. Section 4.3 discusses the data, the sample selection process and the methodology for the empirical tests. Section 4.4 presents the empirical findings about the size of the risk-adjusted return to the strategy and the risk-return characteristics of the strategy. Section 4.5 summarizes the findings and concludes the chapter.

4.2 Hypotheses development

4.2.1 The profitability of the UK merger arbitrage portfolios

The extant evidence shows that the merger arbitrage strategy is highly profitable (Section 2.3.1, Chapter 2). The result is robust not only to the choice of market where the strategy is conducted, i.e. the US, Australia and Canada, but also to different methods of controlling for risk. Thus, we expect a similar result for the UK market. Hence our first hypothesis is:

Hypothesis 4.1: Merge arbitrage strategy is profitable in the UK market and generates a significant positive risk-adjusted return.

4.2.2 Risk-return characteristics of the strategy- regulation impact

As far as the risk to the strategy is concerned, Michell and Pulvino (2001) report that for the US market, the strategy has close-to-zero systematic risk or is market neutral in most market conditions but has significant positive systematic risk during market downturn. Maheswaran and Yeoh (2005) also investigate such non-linear risk-return pattern for the Australian market but find no supporting evidence. The merger arbitrage portfolio consisting of 193 Australian cash mergers from 1991-2000 is close to market neutral in all market conditions. Thus, the non-linear risk-return pattern appears to be unique to the US market.

While the two studies document different empirical results about the risk-return characteristic of merger arbitrage strategy, little is known about why such a difference exists. Maheswaran and Yeoh (2005) offer no explanation about the absence of the non-linearity compared to the study by Michell and Pulvino (2001). To make an inquiry into the source of the difference, the first step is to examine the economic rationale behind the non-linear risk-return pattern of the merger arbitrage strategy.

As the main risk associated with the strategy is the possibility of bid failure, which is generally idiosyncratic, it should be expected that the strategy has little systematic risk under most circumstances. The non-linear risk-return pattern arises when the risk of bid failure increases substantially during severe market downturn. Because the target stock price often correlates with the market movements, when the market is falling it is likely that the target stock price follows suit. Under that circumstance, the bid may fail in two scenarios. First, the bidder may feel that he overpays for a depreciating asset and therefore may abandon the bid (if allowed by the regulatory regime). This scenario is true, nevertheless, mainly for those bids, in which the bidder pays cash in exchange for target stock. In case the bidder uses his own stock in exchange for target stock, because the price of the bidder's stock also falls during market downturn, he may not feel that he overpays for the depreciating target stock.

Second, if the bid is paid for in cash and the bidder finances the bid mainly with debt like a typical leverage buy-out deal, the bid may fail because the bidder may lose the sources of financing. In a severe market downturn, the liquidity in the market dries up due to the so-called 'flight-to-quality' race. As the whole market is in a panic mood, no one wants to hold anything other than risk-free assets e.g. government securities. Under such circumstance, the spreads between risky corporate bonds and Government bonds widen dramatically. This is typically what happened to Long-term Capital Management in 1998[23]. Thus, if the bidder relies on debt to finance the bid, during severe market downturns, it might not be able to obtain the cash at the right cost of debt to pay for the target stock at the initial offer price. Consequently, the bidder may be forced to terminate the bid[24].

The recent case of Dow Chemical's bid for Rohm & Haas on 07/10/2008 clearly illustrates the second scenario. Dow Chemical planned to obtain the cash for the bid via issuing bonds. It is supposed to close the bid on 27/01/2009. However due to the market turmoil at the end of 2008 and early 2009, Dow Chemical was unable to obtain sufficient funding to pay for Rohm & Haas stocks at the initial offer price and decided to back off. On February 2009, Rohm & Haas sued Dow Chemical to Delaware Court for the failure to complete the bid. Even though after 4 months of trial and negotiation, the bid was finally consummated on April 2009, the severe market downturn during the bid period increased the uncertainty about the final outcome of the bid.

Two points can be drawn from the economic rationale behind the non-linear risk-return pattern. First, the pattern, if it exists, is mainly true for the merger arbitrage portfolio containing cash bids. Michell and Pulvino (2001) test this implication and report supporting evidence. The non-linear risk-return pattern is stronger when the portfolio is restricted to cash bids. The portfolio of stock bids is, however, market neutral in all market conditions. Second, the existence of the non-linear pattern crucially depends on the bidder's ability to withdraw from the bid during market downturn. One corollary of this implication is that the pattern should be stronger in jurisdictions that are more

[23] See Lowenstein (2001) and Dunbar (2000) for a detailed description of the case.
[24] It depends on whether the bidder can use the 'market fall' excuse to get out of the bid. There have been a few cases of litigation by targets against bidders and their bankers in the US in recent years. So bidders have to factor in such potential costs.

lenient toward the bidder's tendency to renege on the bid. Thus, takeover regulations may play an important role in explaining why the non-linear pattern exists in the US market but not in Australian market. A closer look at the US and Australian takeover regulation appears to prove this conjecture.

According to Kenyon-Slade (2004, p36), under the US takeover law, the bidder has the flexibility to include conditions in the offer, the fulfilment of which is solely within the hands of the bidder. Regarding the case of market downturn, the US bidder is allowed to specify the so-called 'Market Out Condition' in the offer, which then allow it to terminate the bid in the event of material adverse movements in the bidder's share price, the target's share price or in general share price, say, a market index. Hence, in the US market the risk of bid failure might increase substantially during severe market downturn as the bidder has the economic incentive and is allowed to abandon the bid as long as the bidder can put the 'Market Out Condition' in the offer.

In Australia, the ability of the bidder to terminate the bid at its discretion is more restrictive. Section 662, chapter 6 of the Corporations Act 1989 clearly states that "an offeror shall not make a takeover offer subject to a defeating condition the fulfilment of which depend on (a) an opinion, belief or other state of mind of the offeror or of an associate of the offeror; or (b) whether or not a particular event happens, being an event that is within the sole control of offeror or of an associate of the offeror; and, if a takeover offer is made subject to a condition in contravention of this subsection, the condition is void". It can be seen that the Australian takeover regulation is ambiguous as to whether bidder can abandon the bid citing market downturn as the reason because the 'Market Out'-type condition is not within the bidder's control. It is nevertheless quite obvious that the Australian regulation is less lenient toward the bidder's choice of withdrawing from the bid than the US counterpart. To the extent that the Australian takeover regulation is modelled upon the UK City Takeover Code (Hutson, 2000), which provides a strong case against the leniency toward the bidder's ability to renege on the bid, takeover regulation might help explain why the non-linear risk-return pattern of the merger arbitrage strategy are not present in the Australian market.

Turning to the UK market, its takeover regulation, the City Takeover Code, shows even a stronger case to expect that the non-linear risk-return pattern of the merger arbitrage strategy may not exist here. In light of the General Principle 3 and Rule 2.5 (a) of the City Takeover Code, the bidder, in general, is not allowed to incorporate conditions, subject to which the bidder has the discretion to withdraw from the bid (Kenyon-Slade, 2004 – p496). A bid should only be made when the bidder has very reason to believe that it can and will continue to be able to implement the offer. In contrast to the ambiguity of the Australian takeover regulation over whether bidder can abandon the bid citing market downturn as the reason, the UK City Code explicitly prohibit the bidder from doing so. Note 1, Rule 2.7 of the UK City Code stipulates that "a change in general economic, industrial or political circumstances will not justify failure to proceed with an announced offer"[25]

Thus, in the UK, it is almost impossible for the bidder to abandon the bid during market downturn. Hence the only scenario where the risk of bid failure may increase when the market is falling is when the bidder cannot obtain sufficient financing. Under the UK Takeover Code, this scenario is, however, difficult to be realized. General Principle 3 of the Code clearly states that the bidder must prove that it has sufficient financing to implement the bid before the bid is publicly announced.

Given that it is difficult for either of the two scenarios that increase the risk of bid failure during market downturn to be realized under the UK Takeover Code, we should expect that the non-linear risk-return pattern of the merger arbitrage strategy may not exist in the UK market. The strategy will have zero systematic risk or is market neutral in all market conditions. Hence, our second hypothesis is:

Hypothesis 4.2: Due to the restriction on the bidder's ability to withdraw from the bid during market downturn under the UK takeover regulations, the return to the merger

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[25] Please see the case study about the merger between WPP PLC and Tempus PLC in Sudarsanam (2003, pp.457-8) for an illustration of this restriction under the UK Takeover Code.

arbitrage strategy is related to the market in a linear way and the strategy is market neutral in all market conditions.

4.3 Data and methodology

4.3.1 Data and sample of takeover bids

To test the two hypotheses 4.1 and 4.2 specified in the previous section, we form a merger arbitrage portfolio on the sample of takeover bids described in section 3.2. The sample contains 1105 UK takeover bids from 01 February 1987 to 31 December 2007. Table 4.1 presents some descriptive statistics for this sample. More than 74% of the bids in the sample are paid for in cash. The percentage of cash mergers is similar to the typical US samples (Mitchell and Pulvino, 2001; and Baker and Savasoglu, 2002). While stock mergers only account for 26% of the sample, the average value of a stock merger (£434 millions[26]) is larger than that of a cash merger (£365 millions). For both stock and cash mergers, the mean of transaction value is much larger than the median implying that there are a few very large deals in the sample that skew the distribution of the variable. On average, it takes 78 days for a merger to be completed or terminated. The success rate, the percentage of the mergers that finally go through, is 82% and varies considerably throughout the sample period. The success rate of cash mergers is not distinguishable from that of stock mergers. A paired comparison test, which is not reported for brevity, confirms this fact.

[Insert Table 4.1 here, page 118]

4.3.2 Portfolio construction

There are two approaches to calculating the return to the merger arbitrage portfolio: the event-time portfolio approach and the calendar-time portfolio approach. In the event-time approach, the return from investing in a single bid is first calculated for the period

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[26] The transaction values in different years are converted to 2007 value using the *UK Consumer Price Index – All Urban: All items.*

starting one day after the bid announcement date and ending at the resolution date defined as the date in which the bid is officially consummated or terminated. The return from a single bid is then annualized and the return of the event-time merger arbitrage portfolio is simply the average of the annualized returns from all bids in the sample. The event-time approach faces two serious problems. First, the process of annualizing returns overestimates the actual return on the merger arbitrage portfolio because it implicitly assumes that the return from a single bid can be earned on a continual basis (Dukes et al., 1992). Second, as pointed out by Mitchell and Stafford (2000), since merger events cluster through time and by industry, the cross-sectional dependence among the returns to different arbitrage positions results in incorrect inferences about the statistical significance of the portfolio's risk-adjusted return.

Because of the two problems associated with the event-time approach, this study like the recent studies in the literature employs the calendar-time portfolio approach to calculate merger arbitrage portfolio return. In the calendar-time approach, a takeover bid is included in the portfolio starting one day after the bid announcement and held in the portfolio until the resolution date. For successful bids, the resolution date is the date on which the bid is declared to be effective or unconditional in case the effective date is not available in SDC. For failed bids, the resolution date is the day after the date on which the bid is withdrawn. Using the day after the announcement date as the beginning date for the investment in a bid is consistent with the view that the merger arbitrageurs only trade on public information (Moore, 1999; and Moore et al., 2006). Similarly, using the day after the withdrawn date as the resolution date for merger arbitrage investment in failed bids insured that the arbitrageurs do not exit the bid before the bidder's decision to withdraw from the bid is publicly announced. The portfolio return at each point in time is the weighted average of the returns from the investments in all active bids in the portfolio at that time. Depending on how the returns from individual investment are weighted, different merger arbitrage return series can be generated. As shown below, in this study, we will consider 3 return series.

The methodology to calculate the daily return to the arbitrage position in a single bid is discussed in Section 3.3. The daily return of the merger arbitrage portfolio is the weighted average of the daily returns from all active bids in the merger arbitrage portfolio. The formula to calculate the daily portfolio return is:

$$R_{pt} = \sum_{i=1}^{N_t} w_{it} R_{it} \tag{10}$$

where R_{pt} is the daily portfolio return on day t, R_{it} is the daily return to the arbitrage position in bid i, w_{it} is the weight of the arbitrage position in bid i and N_t is the number of active bids in the portfolio on day t.

In this study, we employ three weighting schemes to generate three series of merger arbitrage return. The first series is produced when the portfolio is equally weighted. For the second series, the portfolio is weighted by the market value of the target firms at the bid announcement date. The third series is created directly from the second series by imposing the restriction that the weight of the investment in each bid does not exceed 10% of the portfolio value. In a survey of 21 merger arbitrage funds, Moore et al. (2006) find that the 10% limit on each position in the portfolio is the standard rule of thumb employed by most arbitrageurs. The limit ensures that the portfolio is insulated from the catastrophic losses caused by the failure of a single bid. In setting up the third series, due to the 10% limit, if there are only a few active bids in the portfolio, some portion of the portfolio will not be invested and remain in cash. For example, if there are 7 active bids in the portfolio on day t, under the 10% limit rule, the arbitrageurs can only invest in the takeover bids up to 70% of the portfolio value, the remaining 30% will be held in cash. We assume that the cash portion of the portfolio is invested in the risk-free bond. In the event that there is no active bid in the portfolio in a particular day, the whole portfolio is invested in the risk-free bond.

Because among the three series, the third one most closely resembles the practical arbitrage portfolio, we call the third series the Practitioner Arbitrage (PA) portfolio return series. The first two series are named after the way they are weighted as the equally weighted portfolio return series and the value weighted portfolio return series.

Finally, due to the econometric problems in the estimation of the asset pricing model using daily return pointed out by Scholes and Williams (1977), like most research in merger arbitrage literature, this project employs the monthly return series. The portfolio monthly return is calculated directly from the daily returns as followings:

$$R_{pj} = \prod_{t=1}^{K_j} (1 + R_{pt}) \tag{11}$$

where R_{pj} is the return to the merger arbitrage portfolio in month j and K_j is the number of trading days in month j.

Figure 4.1 plots the number of active bids in a month for the merger arbitrage portfolios over the sample period. The number of bids in each month varies considerably and exhibits a clustering pattern through time. The number of active bids is high for some periods, for instance 1998- 2001, and is low for the others, for example 1993-1997. This pattern is consistent with the fact that mergers tend to occur in waves (Sudarsanam, 2003).

[Insert Figure 4.1 here, page 126]

Table 4.2 presents some descriptive statistics for the annualized time series of monthly returns for the three arbitrage portfolios, the FTSE All Shares index as the proxy for the market portfolio and the risk-free bond. As shown, the annual compounded return to the arbitrage portfolios, ranging from 13.23% to 15.27%, is greater than the return to the market portfolio which is 10.33%. For all three arbitrage portfolios and the market portfolio, we calculate Sharpe ratio, which is the ratio of the annual return in excess of risk-free return to the annual standard deviation of return. Sharpe ratio shows how much excess returns given one unit of risk a portfolio can generate and it is a measure of how well the portfolio performs. As can be seen in Table 4.2, all three arbitrage portfolios have Sharpe ratios greater than that of the market portfolio indicating that these arbitrage portfolios seem to out-perform the market portfolio.

[Insert Table 4.2 here, page 119]

Figure 4.2 depicts the value over the sample period of £1 investment in the three arbitrage portfolios, the market portfolio, and the risk-free bond starting from 01/02/1987. On 31/12/2007, the investment in the PA portfolio grows into £13.60 but the investment in the market portfolio only translates into £7.86. These initial descriptive statistics indicate that the merger arbitrage strategy appears to perform well in the UK market.

[Insert Figure 4.2 here, page 127]

4.3.3 Empirical tests

To test Hypothesis 4.1 about the performance of the UK merger arbitrage portfolio, we employ the standard linear asset pricing models to estimate the portfolio's risk-adjusted return over the sample period. In addition to the two models employed by other studies namely CAPM and Fama and French (1993) three-factor model, the Carhart (1997) four-factor model is also used to control for risk.

CAPM:

$$R_t^A - R_t^f = \alpha + \beta_M\left(R_t^M - R_t^f\right) + \epsilon_t \tag{12}$$

Fama and French (1993) three-factor model:

$$R_t^A - R_t^f = \alpha + \beta_M\left(R_t^M - R_t^f\right) + \beta_{SMB}SMB + \beta_{HML}HML + \xi_t \tag{13}$$

Carhart (1997) four-factor model:

$$R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{UMD}UMD + \upsilon_t \quad (14)$$

where R_t^A is the monthly return to the merger arbitrage portfolio on month t, R_t^f is the monthly risk-free rate, R_t^M is the monthly return to the market portfolio. In this study, we measure risk-free rate using three-month UK Government bond, and use the FTSE All Share index as the proxy for the market portfolio. SMB is the difference in return between a portfolio of small stocks and a portfolio of big stocks, HML is the difference in return between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. UMD is the difference in return between a portfolio of stocks with high past return and a portfolio of stocks with low past return. The construction of HML and SMB factor for the UK market is similar to the approach adopted by Daniel, Titman and Wei (2001). The construction of HML, SMB and UMD for the UK market follows Liew and Vassalou (2000). β is the systematic risk associated with different risk factors and is estimated with the data. ϵ_t, ξ_t, and υ_t are the error terms of the models. The intercept α measures the average monthly risk-adjusted return. If Hypothesis 4.1 is true, α is significantly positive.

One of the challenges in measuring the performance of a calendar-time portfolio is to obtain the accurate statistical inference about the size of the abnormal returns. As discussed in section 4.3.2, the number of takeover bids in the merger arbitrage portfolios varies considerably over the sample period and exhibit clustering pattern. The clustering pattern of the portfolios' composition may make the volatility of the portfolio return change over time. This in turn leads to the heteroskedasticity problem, which biases the estimate of the standard error of the model. The standard solution is to employ the estimation methods that are robust to any form of heteroskedasticity. In this paper, as we are dealing with time-series data, we will use the Newey and West (1987) procedure to obtain the standard errors that are robust to both heteroskedasticity and autocorrelation problem. In this standard procedure, the specific functional form of heteroskedasticity is not modelled.

Another approach suggested by Benou and Richie (2003) and Hou et al. (2004) is to use the generalized, autoregressive, conditional heteroskedasticity GARCH(1,1) model to directly capture the form of heteroskedasticity. According to Tsay (2005), GARCH(1,1) has the ability to capture most of the stylized facts in the volatility of stock return series. To check the robustness of the inference about the size of the abnormal return, in addition to the Newey and West (1987) procedure, we also estimate the asset pricing models specified in equation (12)-(14) with GARCH(1,1) type heteroskedasticity. In particular, maximum likelihood method will be employed to estimate the following two-equation system:

$$R_t^A - R_t^f = \alpha + \sum_k \beta_k X_k + e_t \tag{15}$$

$$\sigma_{t,e}^2 = \omega + \lambda_1 \sigma_{t-1}^2 + \lambda_2 e_{t-1}^2 + \lambda_3 N_t \tag{16}$$

where β_k measures the systematic risk associated with different risk factors specified in equation (12)-(14); X_k represent the risk factors. For example, in CAPM model (equation (12)), X_k includes only the excess return on the market portfolio; in Fama and French (1993) model, two additional risk factors namely SMB and HML are added to X_k. e_t is the model' residual, $\sigma_{t,e}^2$ is the volatility of the residual of the models. σ_{t-1}^2 and e_{t-1}^2 capture the volatility clustering pattern. N_t is the number of active bids in the portfolio on month t. The innovative feature of the two-equation system (15)-(16) is that changing portfolio composition is directly captured and the impact of the number of bids in the portfolio on the conditional heteroskedasticity can be examined.

To test Hypothesis 4.2 about whether the UK merger arbitrage portfolio has non-linear risk-return pattern, we estimate the following piecewise linear model:

$$R_t^A - R_t^f = \gamma[\alpha_L + \beta_L(R_t^M - R_t^f)] + (1-\gamma)[\alpha_H + \beta_H(R_t^M - R_t^f)] + u_t \qquad (17)$$

where γ is a dummy variable equal to 1 in severe market downturn and 0 in normal market condition. The market is in severe downturn when the market excess return $(R_t^M - R_t^f)$ is below the threshold $(R^{M*} - R^{f*})$. α_H and β_H are the intercept and the coefficient of the model in normal market condition; α_L and β_L are the intercept and the coefficient of the model in severe market downturn. u_t is the error term of the model. For continuity, we impose the following restriction on the model:

$$\alpha_L + \beta_L(R^{M*} - R^{f*}) = \alpha_H + \beta_H(R^{M*} - R^{f*}) \qquad (18)$$

Substituting restriction (18) to the equation (17), we can transform the piecewise linear model into:

$$R_t^A - R_t^f = \alpha_H + \beta_H(R_t^M - R_t^f) + (\beta_L - \beta_H)\gamma[(R_t^M - R_t^f) - (R^{M*} - R^{f*})] + u_t \qquad (19)$$

In this study, we will estimate equation (19) to examine the non-linear risk-return pattern of the merger arbitrage portfolios instead of estimating equation (17) concurrently with the restriction (18), the approach employed by Mitchell and Pulvino (2001) and Maheswaran and Yeoh (2005). Our approach yields several advantages. First, it is technically simpler. We only need to estimate one equation, and as a result it is easier to obtain the standard errors of the coefficient estimates that are robust to heteroskedasticity and serial correlation. Second, as discussed in Section 4.2.2, the main empirical implication of the non-linear risk-returns pattern is that the systematic risk of the merger arbitrage portfolio increases substantially in severe market downturn. This would imply that $\beta_L - \beta_H > 0$. The estimation of equation (19) will provide the direct statistical test of this empirical implication. This assures that the observed difference between β_L and β_H is not just the product of chance. This issue has not been addressed in previous studies.

If a non-linear pattern similar to the one found in the US by Mitchell and Pulvino (2001) is detected, then the payoff pattern of the merger arbitrage portfolio is akin to writing an uncovered put option on the market index. In particular, during the normal market condition, the intercept α_H should be positive reflecting the put premium and the systematic risk β_H should be close to zero. Nonetheless, during severe market downturn, the estimate of β_L should be significantly greater than zero. Following Mitchell and Pulvino (2001), we depict a graphical presentation of such non-linear pattern in the risk-return relation of the merger arbitrage portfolio assuming a negative threshold in Figure 4.3.

[Insert Figure 4.3 here, page 128]

When the risk-return relation is non-linear, Glosten and Jagannathan (1994) suggest that the risk-adjusted return should be estimated using the contingent claim approach. The general idea behind the approach is that the payoffs from £1 investment in the merger arbitrage portfolio can be replicated by a portfolio of an option on the market index and a risk-free bond. The difference between the cost of the replicating portfolio and the £1 investment represents the risk-adjusted return. More details on the contingent-claim approach applied to merger arbitrage portfolio will be presented in Section 4.4.3.

4.4 Empirical result

In this section, we present the empirical results about the profitability and the risk-return characteristics of the merger arbitrage strategy in the UK market. Since the Practitioner Arbitrage portfolio most closely mirrors the real world, our discussion focuses mainly on this portfolio. As most of the previous studies have documented results only for equally weighted and value weighted arbitrage portfolio, to provide a benchmark for comparison we also report the results for these two arbitrage portfolios.

4.4.1 Benchmarking merger arbitrage return using linear asset pricing models

To assess the profitability of the merger arbitrage portfolio in the UK, the first step is to benchmark the portfolio return against the three linear asset pricing models namely CAPM, Fama and French (1993) three-factor model, and Carhart (1997) four-factor model. Table 4.3 shows the result for the entire 251 months (21 years) of the sample period. When CAPM is used as the benchmark to adjust for risk, all three arbitrage portfolios generate significantly positive risk-adjusted returns ranging from 0.5% per month or 6.17% per annum for the Practitioner Arbitrage portfolio (PA) to 0.64% per month or 7.96% per annum for the value weighted portfolio. This result indicates that the strategy is profitable in the UK market on risk-adjusted basis and is consistent with the results reported in other markets.

[Insert Table 4.3 here, page 120]

As far as risk is concerned, the result under CAPM shows that the merger arbitrage portfolios have significant positive market risk. However, the size of the coefficient estimates indicates that the magnitude of market risk is quite small. The size of β_M ranges from 0.11 for the PA portfolio to 0.22 for the value weighted portfolio. This means that for the PA portfolio, when the return to the market portfolio changes by 1%, the return to the PA portfolio only changes by 0.11% in the same direction. Thus, the merger arbitrage portfolio is close to market neutral in the UK market. This result is similar to the findings reported in other markets.

The result is similar when the other two multi-factor models are employed to adjust for risk. As shown in Panel B and C of Table 4.3, the PA portfolio earns significantly positive risk-adjusted return of 0.46% per month when the Fama and French (1993) three-factor model serves as the benchmark for risk adjustment and of 0.59% per month when the Carhart (1997) four-factor model is used. As for risk, the PA portfolio has significant positive exposure to the movement of the market portfolio. The size of such exposure, nevertheless, is small, which is analogous to the result under CAPM. Among other risk factors, except for SMB, the coefficient estimates of HML and UMD are not significantly different from zero. The coefficient estimate of SMB is significantly positive. The positive correlation between the return to the PA portfolio and SMB can be explained by the fact that around a quarter of the PA portfolio are stock bids. As discussed in Section 3.3, the investment in a stock bid involves a long position in the target stock and a short position in the bidder stock. Since the size of the bidder firm is typically larger than that of the target firm, the investment in stock bid is akin to the investment in the SMB portfolio.

The result in Table 4.3 is estimated using the traditional OLS regression with Newey and West (1987) standard errors that are robust to heteroskedasticity and autocorrelation. As a robustness check, we also perform additional analysis in which the heteroskedasticity is directly modelled using GARCH(1,1). We report the result in Table 4.4.

[Insert Table 4.4 here, page 122]

As for the size of the abnormal return, the GARCH(1,1) result is very similar to the result using OLS regression. The abnormal return to the strategy is significantly positive when all three asset pricing models are used as the benchmark for risk adjustment. Regarding risk, the coefficient estimates of different risk factors are of similar magnitudes compared to the estimates under OLS. The estimates of the heteroskedasticity model in equation (9) are worth noticing. Except for the equally weighted arbitrage return series, both the ARCH and GARCH effects of the model (λ_1 and λ_2) are statistically significant at 1% level. This indicates volatility clustering pattern and hence confirms the value of resolving the heteroskedasticity problem. The volatility appears to decrease when the number of active bids in the portfolio increases. This negative relationship is consistent the diversification effect. The more diversified the portfolio is, i.e. the higher number of securities in the portfolio, the more the idiosyncratic risk that can be eliminated, hence the smaller is the total risk.

In summary, our analysis based on three standard linear pricing models shows that the merger arbitrage strategy is profitable on a risk-adjusted basis in the UK market. The result is not only robust to the choice of the asset pricing model but also to different methods to obtain robust standard errors of the coefficient estimates. In all three models - CAPM, Fama and French (1993) three-factor model and Carhart (1997) four-factor model -, the relation between merger arbitrage return and the systematic risk factors is assumed to be linear. The result may be biased nonetheless if the relationship turns out to be non-linear. In the next section, we investigate the non-linear risk-return pattern.

4.4.2 Piecewise linear model

In this section, we perform a formal procedure to examine the non-linear risk-return pattern of the merger arbitrage portfolios. We estimate the piecewise linear model as presented in equation (19). The first issue in estimating the model is to identify the threshold $R^{M*} - R^{f*}$ which separates the sample into two groups: the normal market condition group and the market downturn group. The normal market condition group includes those observations which have the market excess return $R_t^M - R_t^f$ above the threshold; and the market downturn group includes those observations that have the market excess return below the threshold. The empirical implication of the non-linear risk-return pattern is that the slope of the fitted line associated with the market downturn group is significantly greater than the slope of the fitted line associated with the normal market condition group. The threshold represents the kink point as depicted in Figure 4.3.

In order to avoid an arbitrary choice of the threshold, we follow the approach suggested by Mitchell and Pulvino (2001). In particular, the threshold is defined as the point that best fit the model with the data. In other words, the threshold is the value that minimizes the sum of squared residuals of the model. Equivalently, it is the value that maximizes the model's adjusted R^2. To select such threshold, our approach is to estimate the model with a wide range of thresholds and the select the value that give the highest adjusted R^2. As the threshold is supposed to signal a market downturn, we vary the threshold $R^{M*} - R^{f*}$ from 0% down to -28%. To go from 0% down to -28%, we use the step size of -0.1%. This translates into running 280 regressions with 280 different thresholds. Although the smallest value of the market excess returns is -27.24%, we set the minimum value for the range of the thresholds to be -28% for the following reason. If the threshold falls below -27.24%, this would mean that there is no observation in the market downturn group. Therefore, the linear model as presented in equation (12) is better fit with the data than the non-linear piecewise model. If that is the case, we can conclude that the non-linear pattern does not exist in the UK market. Figure 4.4 plots the model's adjusted R^2 corresponding to different thresholds.

[Insert Figure 4.4 here, page 129]

Interestingly, all three arbitrage return series show the same pattern. There are a range of thresholds from -12.2% down to -27.2% that maximize that the model's adjusted R^2. One common feature of these thresholds is that it separates the sample into exactly the same two groups. The market downturn group includes only one observation, which has the smallest market excess return of -27.24%, and the remaining observations belong to normal market condition group. Due to this common feature, the results for the piecewise linear model using different thresholds in the maximizing range are very similar to one another. Thus, we set the threshold to -12.2% to estimate the piecewise linear model. The estimation result for the three return series is presented in Panel A of Table 4.5.

[Insert Table 4.5 here, page 124]

For the PA portfolio and the equally weighted portfolio, in normal market condition the portfolio's market risk (β_H) is indistinguishable from zero. For all three return series, when the market is in severe downturn ($R^{M*} - R^{f*} < -12.2\%$), the portfolios' market risk increases remarkably. The increase in market risk during market downturn is statistically significant at 1% level. For the PA portfolio, the market beta rises by more than 5.5 times during market downturn (from 0.0789 to 0.4396). The significant difference between the portfolios' normal market condition beta and market downturn beta indicates a possible non-linear risk-return pattern. The economic rationale behind the pattern discussed in section 4.2.2 has shown that if the non-linear pattern exists, such pattern is mainly true for the portfolio of cash bids. To examine this idea, we also perform additional estimation of the piecewise linear model for two separate samples of cash and stock bids. Panel B and C of Table 4.5 present the estimates of the piecewise linear model when the sample is restricted to either cash or stock bids. As anticipated, the non-linearity pattern is only applicable for the merger arbitrage investment in cash bids. For all three return series, the downmarket beta is significantly larger than the normal market condition beta when the sample is limited to cash bids. When only stock bids are considered, the difference between the downmarket beta and normal market condition beta is nil.

The results so far present striking similarity with the US study by Michell and Pulvino (2001), who find a strong non-linear risk-return pattern for the US merger arbitrage portfolio. Is this then evidence against our hypothesis of a link between the takeover regulation and the risk-return pattern of the merger arbitrage strategy (Hypothesis 4.2)? If this hypothesis were true, we would not expect to see a non-linear pattern in the UK market between the merger portfolio return and market risk.

Therefore, it is worthwhile to examine the strength of the non-linear pattern found in this UK sample. Compared to the pattern found in the US, the strength of the non-linear pattern in the UK is much smaller. The threshold to separate the severe market downturn condition from other market conditions is much lower in absolute value in the US market compared to the UK market. As reported by Mitchell and Pulvino (2001), the threshold for the US market is −4%. The threshold found in this study for the UK market, −12.2%, is more than triple the US threshold in absolute value. The market decline has to be substantially steeper in the UK than in the US before the non-linear effect seems to come into play.

To illustrate the magnitude of the difference in the non-linear risk-return relation of the merger arbitrage strategy between the two markets, suppose the −4% threshold of the US market is applied to the UK sample utilized in this study. If it is the case, the return to the merger arbitrage portfolio will have positive correlation with the market return in 37 months (out of 251 months of the whole sample period). If the UK threshold of −12.2% is applied, the merger arbitrage portfolio is positively correlated with the market only in 1 month. Interestingly, that unique month is October 1987, the month when one of the biggest crashes in financial market history occurred.

The occurrence of a market crash like the one in October 1987 is extremely rare. From 1900s till now, such an event has happened only twice. The other one was in 1929 preceding the Great Depression[27]. The fact that the return to UK merger arbitrage portfolios has positive market risk due to only one month's market movement and such a month coincides with a very rare event in financial market history suggests that the observed non-linearity is due to an outlier.

Figure 4.5 plots the graphical presentation of the result of the piecewise linear model estimation. If the non-linear pattern is present, we should see two clusters of observations showing two fitted lines with different slopes. The pattern shown in Figure 4.5 is nowhere near that. It seems that there is only one cluster of observations and one outlier, which is the observation corresponding to the October 1987 market crash. If this is true, then when we remove the outlier the linear risk-return pattern with one fitted line will be best matched with the data.

[Insert Figure 4.5 here, page 130]

Figure 4.6 plots the adjusted R^2 of the piecewise linear model against different thresholds ranging from 0% down to -28% when the observation related to the October 1987 market crash is removed from the sample. For all 3 return series there are a range of thresholds from -12.2% to -28% that give the highest adjusted R^2 for the model. The common feature of these thresholds is that there is no observation in the market downturn group. This would mean that there is no threshold at which the slope of the regression line changes from zero to positive i.e. the slope is flat throughout. As we argue earlier, this finding indicates that the linear model is best fit with the data. Thus, when we remove the outlier, the non-linear pattern observed in Table 4.5 disappears.

Our analysis suggests that the non-linear risk-return pattern in the UK, if it exists, is much weaker than the pattern reported in the US market. Furthermore, the pattern seems

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[27] The recent crash in the stock market lies outside the sample period.

to be driven entirely by one single observation, which is the October 1987 market crash, a very rare event in financial market history. When such observation is removed from the sample, the non-linear risk-return pattern no longer exists. The weak empirical support for the presence of the non-linear risk-return pattern in the UK market is consistent with Hypothesis 4.2. Due to the restrictions under the UK Takeover Code on the bidder's ability to abandon the bid during severe market downturn, the non-linear pattern may not exist in the UK market.

4.4.3 Contingent claim approach to estimate risk-adjusted return

This section serves as a robustness check for estimation of the merger arbitrage risk-adjusted return. By using the contingent-claim approach, we can control for any possible non-linear risk return pattern in the UK. If the non-linearity does not exist, the result should be similar to those reported using the linear asset pricing model. The general idea of the approach is that the payoffs to £1 investment in the merger arbitrage portfolio can be replicated using a portfolio of an option on the market index and a risk-free bond. If the cost of the replicating portfolio is $£(1 + x)$ then x measures the risk-adjusted return.

To set up the replicating portfolio, the first step is to examine the payoff pattern of £1 investment in the merger arbitrage portfolio. Because of the possible non-linear risk-return relation, the payoff to the arbitrage portfolio in severe market downturn might differ from the payoff in other market conditions. In particular, when the market excess return is above a threshold (-12.2%), the payoff to the portfolio depends very little on the market movement. As shown in Panel A of Table 4.5, for the Practitioner Arbitrage Portfolio, the market beta, when the market excess return is above the threshold (hereafter 'upmarket' beta), is only 0.0789. This upmarket beta is not statistically different from zero. Thus in practical terms, we can set the upmarket beta to be zero. From equation (17), we can write the average monthly payoff to the £1 investment in the merger arbitrage portfolio when the market excess return is above the threshold as: $1 + R^f + \alpha_H$, where R^f is the sample average monthly risk-free rate and α_H is the upmarket intercept reflecting the average monthly rate of return in excess of risk-free rate to the arbitrage portfolio in normal market conditions. By substituting equation (18) into equation (17), the average monthly payoff to £1 investment in the merger arbitrage portfolio when the market excess return is below the threshold can be written as

$$1 + \alpha_H + \beta_L[(R^M - R^f) - (R^{M*} - R^{f*})]$$

where β_L is the market beta when the market excess return is below the threshold (hereafter 'downmarket' beta), R^M is the sample average monthly rate of return to the market portfolio and $R^{M*} - R^{f*}$ is the market excess return threshold (-12.2%). The average monthly payoffs to £1 investment in the merger arbitrage portfolio are summarized as follows:

	Payoff to the portfolio
$R^M - R^f \geq R^{M*} - R^{f*}$	$1 + R^f + \alpha_H$
$R^M - R^f < R^{M*} - R^{f*}$	$1 + \alpha_H + \beta_L[(R^M - R^f) - (R^{M*} - R^{f*})]$

This payoff pattern can be replicated with a portfolio that is long in a risk-free bond and is short in β_L number of put options on an index. The return on the index is equal to the market excess return. Because we try to replicate the monthly payoff pattern, both the risk-free bond and the put option have one month time to maturity. The face value of the bond is

$$1 + R^f + \alpha_H$$

If we assume the current value of the index is 1, the exercise price or the option is

$$1 + (R^{M*} - R^{f*})$$

In all market conditions, the bond will pay

$$1 + R^f + \alpha_H$$

Because the return on the index is the market excess return, the realized value of the index in 1 month is $1 + (R^M - R^f)$. The payoff to the short position in β_L number of put options is 0 when the market excess return is above the threshold and is

$$\beta_L[(R^M - R^f) - (R^{M*} - R^{f*})]$$

when the market return is below the threshold. It is easy to check that the payoff to the replicating portfolio is exactly the same as the payoff to the £1 investment in the merger arbitrage portfolio.

The final step in calculating the risk-adjusted return under the contingent claim approach is to figure out the cost of the replicating portfolio, which is simply the price of a bond less the premium receive from shorting the put option. Assuming that Black-Scholes option pricing model is applicable, the cost of the replicating portfolio is therefore:

$$\frac{1 + R^f + \alpha_H}{1 + R^f} - \beta_L P(X, S, R_A^f, \sigma, T - t) \tag{20}$$

where $P(X, S, R_A^f, \sigma, T - t)$ is the Black-Scholes price of the put option on the index. The current market index level (S) is 1, the exercise price of the option (X) is $1 + (R^{M*} - R^{f*})$, the annual risk-free rate (R_A^f) is 6.85% (sample average), the time to expiration date ($T - t$) is one month; and finally the volatility of the index (σ) calculated from the historical data is 15.53%. Plugging in these inputs to the Black-Scholes formula and the parameter estimates from the piecewise linear model to equation (20), the cost of the replicating portfolio can be easily computed.

Table 4.6 presents the result of the estimation of the risk-adjusted return using the contingent claim approach for all three merger arbitrage return series. For the PA portfolio, the cost of the replicating portfolio is £1.0052, which is £0.0052 more expensive than the investment in the merger arbitrage portfolio. This implies that the PA portfolio generates 0.52% return in excess of risk per month. Compared to the result using linear asset pricing model as the benchmark for risk adjustment in Table 4.3 and Table 4.4, the magnitude of the risk adjusted return under the contingent claim approach is very similar. This is also true for the value weighted and the equally weighted portfolio.

[Insert Table 4.6, page 125 here]

The result confirms that merger arbitrage is highly profitable in the UK. Further, the similarity between the results using the linear pricing model and those using the contingent claim approach suggests that the non-linear risk-return pattern is of little economic importance in the UK market. This again illustrates the impacts of the UK takeover regulation on the risk-return characteristics of the merger arbitrage strategy.

4.5 Chapter summary

In this chapter, we perform the first empirical project testing the risk-based hypothesis. We aim at exploring the magnitude of the risk-adjusted return to the UK merger arbitrage portfolio and examining the risk-return characteristics of the strategy and the impact of takeover regulations on the strategy's risk-return characteristics.

Previous studies, from the US, Canada and Australia, of the return to merger arbitrage strategies have generally documented significant positive risk-adjusted return. While the US study by Mitchell and Pulvino report a significant non-linear relation between (systematic) risk and return, the Australian study by Maheshwaran and Yeoh does not. We argue that this non-linearity is a reflection of the effect of takeover laws and that it is less likely to be observed in takeover regimes that prohibit bidders from abandoning their bids during severe stock market downturns. In the US where takeover laws allow 'market out' clauses in merger agreements, bidders can walk away more easily from their bids, thereby causing merger arbitrageurs to incur heavy losses in market downturns. In more stringent regimes like the UK's, this relation between market downturns and merger arbitrage losses is less likely. Thus non-linearity in risk-return relation in merger arbitrage payoffs is conditional upon the takeover regime. In this chapter, we seek to test the hypothesis that in the UK, an exemplar of a tough takeover regime, non-linearity is unlikely to be observed.

With a sample of 1105 UK cash and stock mergers over the period of 1987-2007, this empirical project is the first to provide empirical evidence about the profitability and the risk-return characteristic of the merger arbitrage strategy in the UK market. Consistent with the findings in other markets, the UK merger arbitrage portfolios perform very well and generate significant positive risk-adjusted return. The result is robust to a range of methods to control for risk.

The major contribution of the empirical analysis of the chapter is to show how takeover regulations can affect the risk-return characteristics of merger arbitrage strategy and to provide empirical evidence of such impact. The finding that there is little evidence supporting the non-linear risk-return pattern of the strategy in the UK is in line with the restrictions on bidder's ability to abandon the bid imposed by UK Takeover Code. Combined with the evidence in the US market (strong non-linearity) and Australian market (no non-linearity), the impact of takeover regulation is confirmed.

Table 4.1: Sample description

This table presents a summary of the takeover bids used in this chapter. Only pure cash and pure stock bids are included. The bid duration is the number of days from the announcement date to the date when the transaction is completed or terminated. The transaction value in GBP is recorded in SDC. Success rate is the percentage of the transactions reported as "completed" or "unconditional" in SDC over total number of transactions. For bid duration and transaction value, the figure in the parentheses is median, the other one is mean. The transaction values in different years are converted to 2007 value using the *UK Consumer Price Index – All Urban: All items.*

	Cash Mergers				Stock Mergers			
Year	No. of deals	Average Value (£mil)	Duration (day)	Success Rate (%)	No. of deals	Average Value (£mil)	Duration (day)	Success Rate (%)
1987	10	610.47 (211.38)	76 (37)	60.00	10	506.06 (66.77)	60 (59)	70.00
1988	19	950.62 (109.39)	100 (70)	63.16	6	144.29 (17.59)	251 (69)	83.33
1989	34	464.96 (71.43)	108 (70)	70.59	11	89.46 (33.50)	41 (43)	81.82
1990	23	100.76 (21.58)	157 (65)	65.22	7	78.62 (37.93)	128 (85)	71.43
1991	27	92.92 (37.92)	114 (64)	70.37	19	337.45 (25.84)	64 (46)	78.95
1992	15	84.71 (22.46)	57 (38)	86.67	8	47.00 (34.20)	86 (64)	75.00
1993	19	163.60 (14.35)	98 (71)	78.95	9	47.52 (23.38)	58 (39)	100.00
1994	14	75.99 (27.91)	67 (65)	85.71	11	284.01 (47.56)	56 (31)	72.73
1995	22	192.53 (30.79)	91 (66)	86.36	9	81.99 (28.98)	42 (36)	88.89
1996	15	213.35 (36.93)	73 (49)	93.33	16	441.72 (79.31)	153 (55)	81.25
1997	33	290.36 (85.13)	70 (64)	84.85	17	78.45 (48.36)	66 (53)	76.47
1998	55	126.82 (39.69)	74 (73)	85.45	22	668.60 (51.14)	66 (64)	72.73
1999	81	129.00 (45.36)	72 (71)	87.65	32	337.40 (40.45)	82 (63)	75.00
2000	66	295.88 (51.53)	69 (67)	81.82	23	639.87 (66.80)	69 (63)	82.61
2001	30	213.52 (21.96)	72 (70)	100.00	13	948.71 (16.79)	58 (48)	92.31
2002	40	62.53 (17.83)	73 (53)	95.00	9	1022.58 105.77)	66 (55)	100.00
2003	61	166.62 (33.37)	90 (50)	90.16	13	69.01 (35.23)	62 (43)	84.62
2004	33	264.24 (78.97)	65 (53)	81.82	10	113.14 (19.86)	67 (47)	100.00
2005	65	403.32 (92.74)	75 (65)	83.08	12	333.25 (65.98)	83 (65)	83.33
2006	102	779.42 (100.99)	69 (63)	78.43	16	1187.68 (98.28)	62 (59)	68.75
2007	62	1030.36 (92.26)	67 (61)	82.26	6	1207.79 146.99)	74 (67)	83.33
Complete Sample	826	365.14 (51.32)	79 (64)	82.81	279	433.61 (40.78)	77 (54)	80.65

Table 4.2: Annual arbitrage portfolio return series

This table presents the annual return series for 3 merger arbitrage portfolios. In the equally weighted portfolio, the returns from individual bids are equally weighted. In the value weighted portfolio, the weight of each individual bid is based on the market value of the target firm. The Practitioner portfolio is created from the value weighted portfolio by imposing the 10% limit on the weight of individual bid. Sharpe ratio is the ratio of the return in excess of risk-free rate to the standard deviation of return.

	Risk-free Rate	Market Portfolio Return	Practioner Portfolio Return	Value Weighted Portfolio Return	Equally Weighted Portfolio Return
1987	8.46	0.07	-0.38	-10.11	-13.25
1988	9.59	11.53	10.11	24.65	33.75
1989	13.15	36.09	10.39	14.98	9.31
1990	14.20	-9.72	4.71	7.85	-0.37
1991	11.02	20.80	7.10	24.95	6.15
1992	9.08	20.49	-15.35	0.15	-18.01
1993	5.28	28.39	28.93	64.09	37.17
1994	5.19	-5.85	29.05	40.07	45.92
1995	6.45	23.85	12.78	10.13	19.10
1996	5.89	16.70	34.95	37.18	53.77
1997	6.54	23.56	6.13	4.56	5.71
1998	7.05	13.77	20.76	9.62	15.27
1999	5.15	24.20	34.09	35.31	35.67
2000	5.88	-5.90	14.36	5.58	10.43
2001	4.94	-13.29	12.34	9.01	3.80
2002	3.89	-22.68	28.43	25.15	36.87
2003	3.60	20.86	25.26	23.54	35.04
2004	4.44	12.84	4.17	-1.27	3.40
2005	4.61	22.04	3.45	3.60	4.14
2006	4.67	16.75	24.99	32.08	19.74
2007	5.59	5.32	-2.32	-12.11	2.55
Annually Compounded Rate of Return	6.85	10.32	13.23	15.27	14.95
Annual Standard Deviation of Return	0.80	15.53	10.46	18.12	13.79
Sharpe Ratio (Annual)		0.22	0.61	0.46	0.59

Table 4.3: Benchmarking merger arbitrage return series with linear pricing models

This table presents the result when the return to merger arbitrage portfolio is benchmarked against Capital Asset Price Model (CAPM), Fama and French (1993) three-factor model (F&F), and Carhart (1997) four-factor model (C4):

CAPM: $R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \epsilon_t$ (12)

F&F: $R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \beta_{SMB}SMB + \beta_{HML}HML + \xi_t$ (13)

C4: $R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{UMD}UMD + \upsilon_t$ (14)

where R_t^A is the monthly return to the merger arbitrage portfolios, R_t^f is the risk-free rate, R_t^M is the return to the market portfolio. We measure risk-free rate using three-month UK Government bond, and use FTSE All share index as the proxy for the market portfolio. SMB is the difference in return between a portfolio of small stocks and a portfolio of big stocks, HML is the difference in return between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. UMD is the difference in return between a portfolio of stocks with high past return and a portfolio of stocks with low past return. β is the systematic risk associated with different risk factors. The intercept α measures the average monthly risk-adjusted return. ϵ_t, ξ_t, and υ_t are the error terms of the models. Newey and West (1987) heteroskedasticity and autocorrelation consistent standard error of the coefficient estimates is reported in the parenthesis.

Dependent Variables	α	β_M	β_{SMB}	β_{HML}	β_{UMD}	Adj.R^2	Sample Size
Panel A: Capital Asset Pricing Model (CAPM)							
Practitioner portfolio return	0.0049***	0.1087**				0.0214	251
	(0.0019)	(0.0496)					
Value weighted portfolio return	0.0064**	0.2180***				0.0542	251
	(0.0025)	(0.0696)					
Equally Weighted portfolio return	0.0060**	0.1470*				0.0229	251
	(0.0025)	(0.0836)					

Dependent Variables	α	β_{M}	β_{SMB}	β_{HML}	β_{UMD}	Adj.R^2	Sample Size
Panel B: Fama and French (1993) three-factor model							
Practitioner portfolio return	0.0046**	0.1536***	0.1820***	0.0927		0.0490	251
	(0.0019)	(0.0484)	(0.0568)	(0.0757)			
Value weighted portfolio return	0.0057**	0.2952***	0.3077***	0.1723		0.1036	251
	(0.0024)	(0.0710)	(0.0841)	(0.1142)			
Equally Weighted portfolio return	0.0062**	0.1991**	0.2213***	0.0811		0.0469	251
	(0.0026)	(0.0834)	(0.0732)	(0.1001)			
Panel C: Carhart (1997) four-factor model							
Practitioner portfolio return	0.0059***	0.1223**	0.1036*	0.1294	-0.0122	0.0484	251
	(0.0020)	(0.0578)	(0.0534)	(0.0814)	(0.1043)		
Value weighted portfolio return	0.0079***	0.2432***	0.1784**	0.1655	-0.0843	0.0983	251
	(0.0028)	(0.0854)	(0.0832)	(0.1124)	(0.1231)		
Equally Weighted portfolio return	0.0065**	0.1878*	0.1592**	0.0984	0.1077	0.0466	251
	(0.0029)	(0.0981)	(0.0719)	(0.1062)	(0.1329)		

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 4.4: Benchmarking merger arbitrage return series with linear pricing models –GARCH

This table presents the result from the re-estimation of the 3 models in Table 4.3 using GARCH (1,1) to model the form of heteroskedasticity. Maximum likelihood method is employed to estimate the following two-equation system:

$$R_t^A - R_t^f = \alpha + \sum_k \beta_k X_k + e_t \qquad (15)$$

$$\sigma_{t,e}^2 = \omega + \lambda_1 \sigma_{t-1}^2 + \lambda_2 e_{t-1}^2 + \lambda_3 N_t \qquad (16)$$

where R_t^A is the monthly return to the merger arbitrage portfolios, R_t^f is the risk-free rate β_k measures the systematic risk associated with different risk factors specified in equation (12)-(14); X_k represent the risk factors. e_t is the model' residual, $\sigma_{t,e}^2$ is the volatility of the residual of the models. σ_{t-1}^2 and e_{t-1}^2 capture the volatility clustering pattern. N_t is the number of active bids in the portfolio on month t. The standard errors of the coefficient estimates are shown in the parentheses.

Dependent Variables	α	β_M	β_{SMB}	β_{HML}	β_{UMD}	λ_1	λ_2	λ_3
Panel A: Capital Asset Pricing Model (CAPM)								
Practitioner portfolio return	0.0060***	0.1382***				0.7823***	0.1294***	-0.0146
	(0.0018)	(0.0342)				(0.0702)	(0.0412)	(0.0261)
Value weighted portfolio return	0.0063***	0.1873***				0.8317***	0.0973**	-0.0062
	(0.0024)	(0.0389)				(0.0886)	(0.0382)	(0.0220)
Equally Weighted portfolio return	0.0089***	0.1174***				0.1174	0.0428	-0.0736***
	(0.0024)	(0.0411)				(0.4029)	(0.0532)	(0.0122)

Dependent Variables	α	β_M	β_{SMB}	β_{HML}	β_{UMD}	λ_1	λ_2	λ_3
Panel B: Fama and French (1993) three-factor model								
Practitioner portfolio return	0.0060***	0.1689***	0.1301**	0.0382		0.7366***	0.1424***	-0.0205
	(0.0018)	(0.0401)	(0.0574)	(0.0850)		(0.0850)	(0.0479)	(0.0216)
Value weighted portfolio return	0.0076***	0.2486***	0.2535***	0.1503		0.0674***	0.0674***	-0.0364***
	(0.0026)	(0.0542)	(0.0634)	(0.1161)		(0.0255)	(0.0255)	(0.0089)
Equally Weighted portfolio return	0.0082***	0.1597***	0.1549**	0.0090		0.1077	0.0447	-0.0752***
	(0.0024)	(0.0501)	(0.0675)	(0.0978)		(0.4122)	(0.0571)	(0.0125)
Panel C: Carhart (1997) four-factor model								
Practitioner portfolio return	0.0072***	0.1597***	0.0419	0.1593*	0.0225	0.7503***	0.1416***	-0.0235
	(0.0019)	(0.0501)	(0.0598)	(0.0909)	(0.0944)	(0.0785)	(0.0468)	(0.0211)
Value weighted portfolio return	0.0096***	0.1869***	0.1072*	0.1893*	-0.0897	0.7911***	0.0826***	-0.0400***
	(0.0026)	(0.0525)	(0.0629)	(0.1064)	(0.1187)	(0.0790)	(0.0299)	(0.0086)
Equally Weighted portfolio return	0.0093***	0.1195**	0.0675	0.1883*	-0.0094	0.0944	0.0826***	-0.0799***
	(0.0025)	(0.0479)	(0.0621)	(0.1103)	(0.1095)	(0.3765)	(0.0299)	(0.0124)

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 4.5: Piecewise linear model

This table presents the result in estimating the piecewise linear model relating the merger arbitrage return to market return:

$$R_t^A - R_t^f = \alpha_H + \beta_H(R_t^M - R_t^f) + (\beta_L - \beta_H)\gamma[(R_t^M - R_t^f) - (R^{M*} - R^{f*})] + u_t \quad (19)$$

where R_t^A is the monthly return to the merger arbitrage portfolios, R_t^f is the risk-free rate, R_t^M is the return to the market portfolio. γ is a dummy variable equal to 1 in severe market downturn and 0 in normal market condition. The market is in severe downturn when the market excess return $(R_t^M - R_t^f)$ is below the threshold $(R^{M*} - R^{f*})$. α_H and β_H are the intercept and the coefficient of the model in normal market condition; α_L and β_L are the intercept and the coefficient of the model in severe market downturn. u_t is the error term of the model. Newey and West (1987) heteroskedasticity and autocorrelation consistent standard errors of the coefficient estimates are reported in the parenthesis.

Dependent Variables	α_H	β_H	β_L-β_H	Threshold	Adj. R^2
		Panel A: Complete Sample			
Practitioner portfolio return	0.0053***	0.0789	0.3607***	-0.1220	0.0281
	(0.0018)	(0.0497)	(0.0929)		
Value weighted portfolio return	0.0069***	0.1698***	0.5825***	-0.1220	0.0536
	(0.0025)	(0.0622)	(0.1164)		
Equally Weighted portfolio return	0.0072***	0.0760	0.8588***	-0.1220	0.0540
	(0.0024)	(0.0647)	(0.1211)		
		Panel B: Cash Deals			
Practitioner portfolio return	0.0035**	0.1441***	0.2919***	-0.1220	0.0730
	(0.0018)	(0.0441)	(0.0846)		
Value weighted portfolio return	0.0078**	0.2222***	1.2457***	-0.1220	0.1175
	(0.0033)	(0.0787)	(0.1536)		
Equally Weighted portfolio return	0.0071**	0.2409***	1.3208***	-0.1220	0.1135
	(0.0034)	(0.0885)	(0.1698)		
		Panel C: Stock Deals			
Practitioner portfolio return	0.0031**	-0.0844**	0.1095	-0.0870	0.0143
	(0.0014)	(0.0419)	(0.0771)		
Value weighted portfolio return	0.0078**	0.2222***	1.2457	-0.1220	0.0202
	(0.0033)	(0.0733)	(1.3462)		
Equally Weighted portfolio return	0.0096	-0.3589	0.0874	-0.0100	0.0196
	(0.0074)	(0.2537)	(0.3755)		

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 4.6: Risk adjusted return estimation using contingent claim approach

This table presents the result in estimating the risk-adjusted return to the merger arbitrage portfolio using contingent claim analysis. The payoff to £1 investment in the merger arbitrage portfolio is replicated by a portfolio that is long in one risk-free bond with the face value of $1 + R^f + \alpha_H$ and short β_L number of put options on the market index. The price of the put option is calculated using Black-Scholes fomula.

	Practitioner portfolio	Value weighted portfolio	Equally Weighted portfolio
α_H	0.0053	0.0069	0.0072
β_L	0.4396	0.7523	0.8660
Risk-free rate (monthly)	0.56%	0.56%	0.56%
Price of the bond	1.0052	1.0069	1.0071
Input for Black-Scholes formula:			
Current Market Index	1	1	1
Exercise Price	0.8780	0.8780	0.8780
Time to expiration (years)	0.0833	0.0833	0.0833
Risk-free Rate (annually)	6.85%	6.85%	6.85%
Volatity (annually)	15.53%	15.53%	15.53%
Price of the put option	0.000014	0.000014	0.000014
Cost of the replicating portfolio	1.005232	1.006851	1.007134
Risk-adjusted return (monthly)	0.52%	0.69%	0.71%

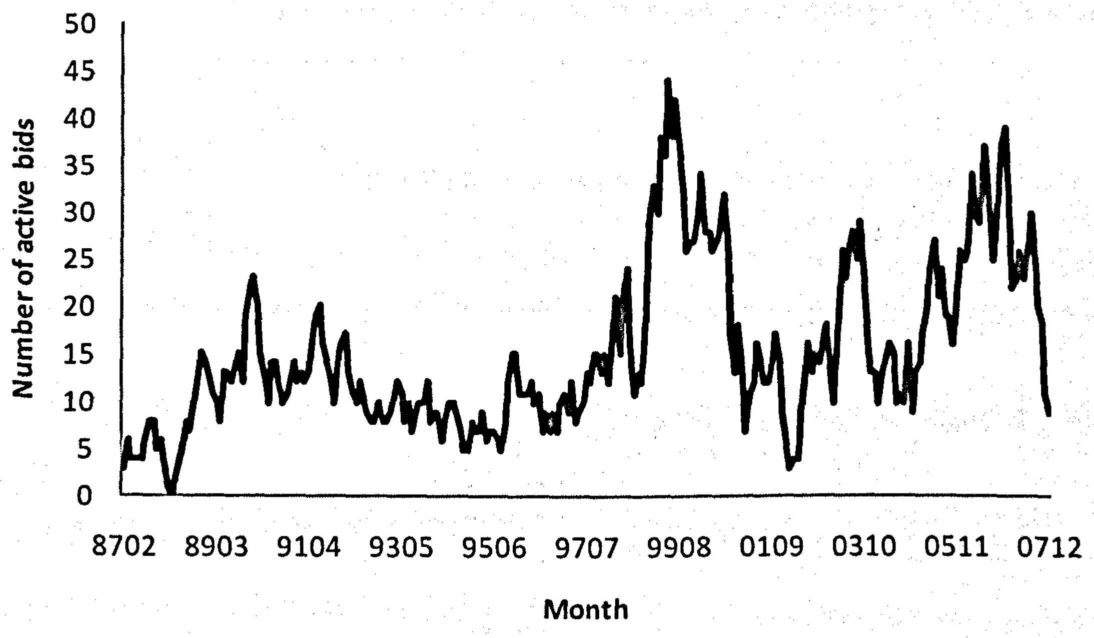

Figure 4.1: Number of active bids in each month from 1987-2007

This figure plots the number of active bids in the merger arbitrage portfolio in a particular month over the period 1987 – 2007.

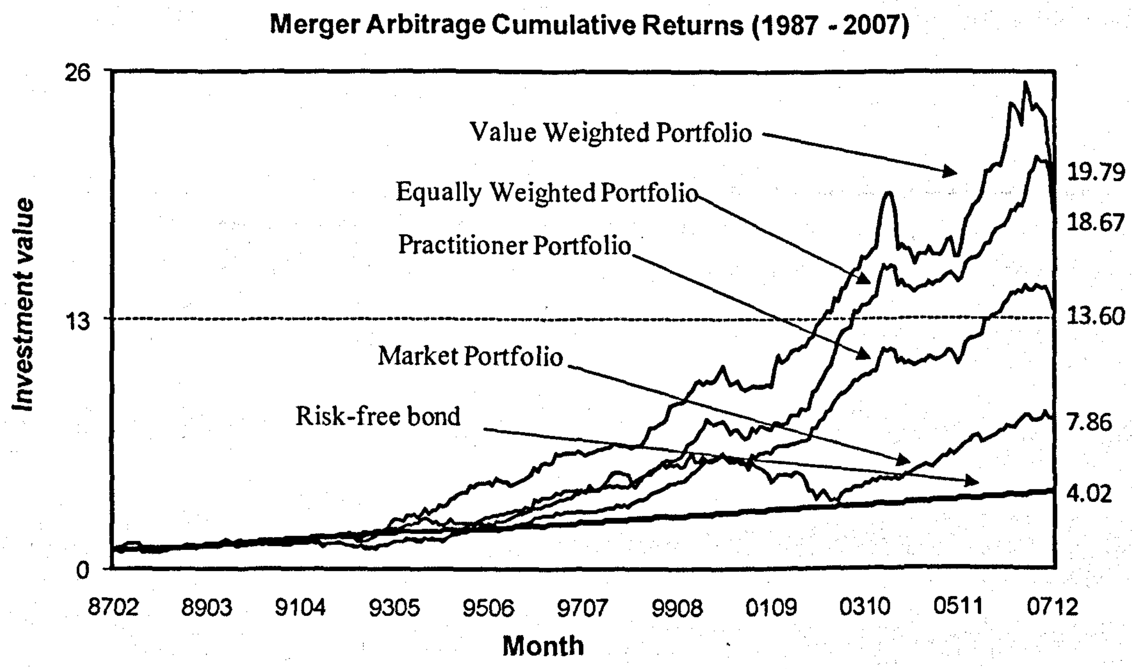

Figure 4.2: Growth of arbitrage investment from 1987 to 2007

This figure plots the value, over the time period of 01/02/1987 to 31/12/2007, of £1 investment at 01/02/1987 in three merger arbitrage portfolio return series, the risk-free bond and the market portfolio.

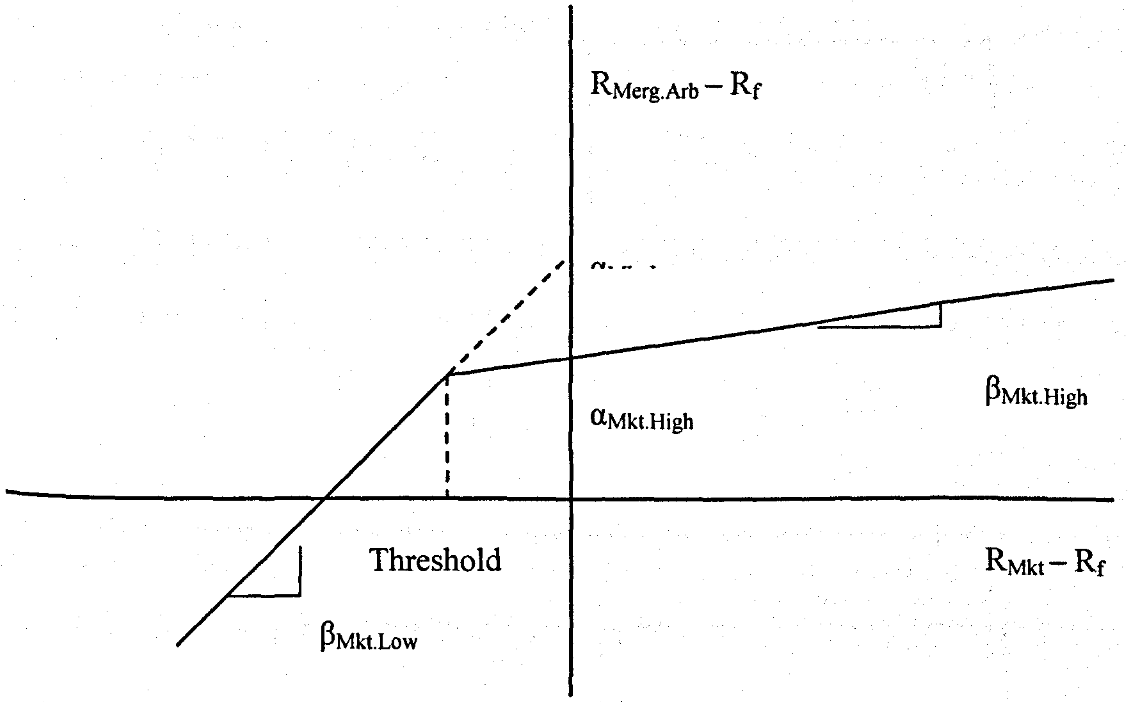

Figure 4.3: Piecewise linear model

This figure plots the piecewise linear model specified in equation (17)-(19). This figure follows figure 2 in Mitchell and Pulvino (2001). $R_{Merg.Arb}$ is the monthly return to the merger arbitrage portfolio, R_f is the risk-free rate, R_{Mkt} is the return to the market portfolio. $\beta_{Mkt.Low}$ and $\alpha_{Mkt.Low}$ are the slope coefficient and the intercept when the difference between the market return and the risk-free rate is below the threshold. $\beta_{Mkt.High}$ and $\alpha_{Mkt.High}$ are the slope coefficient and the intercept when the difference between the market return and the risk-free rate is above the threshold.

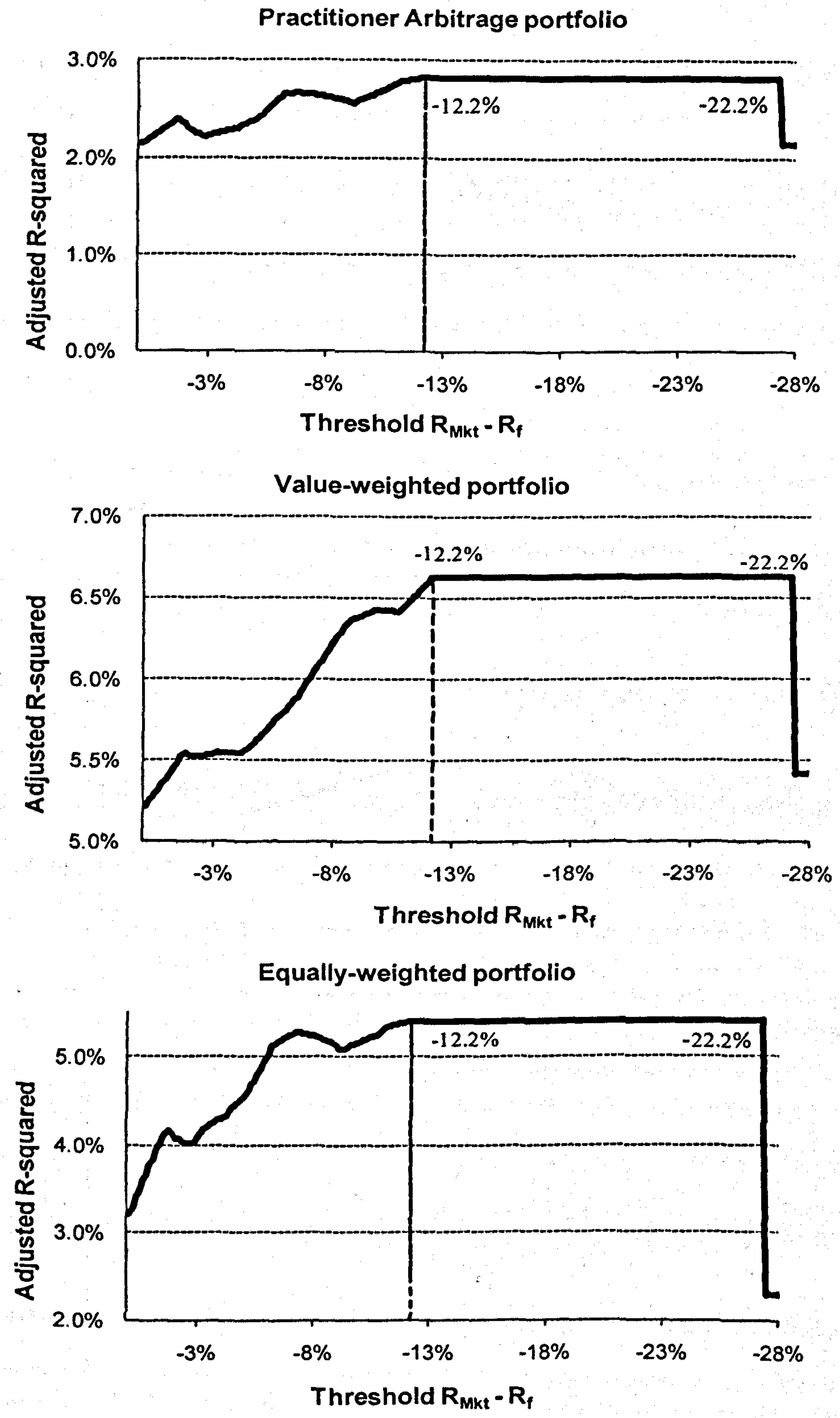

Figure 4.4: Adjusted R-square against market excess return thresholds-full sample

This figure depicts the value of the model's adjusted R-squared against different market excess return threshold in the piecewise linear regression in equation (19)

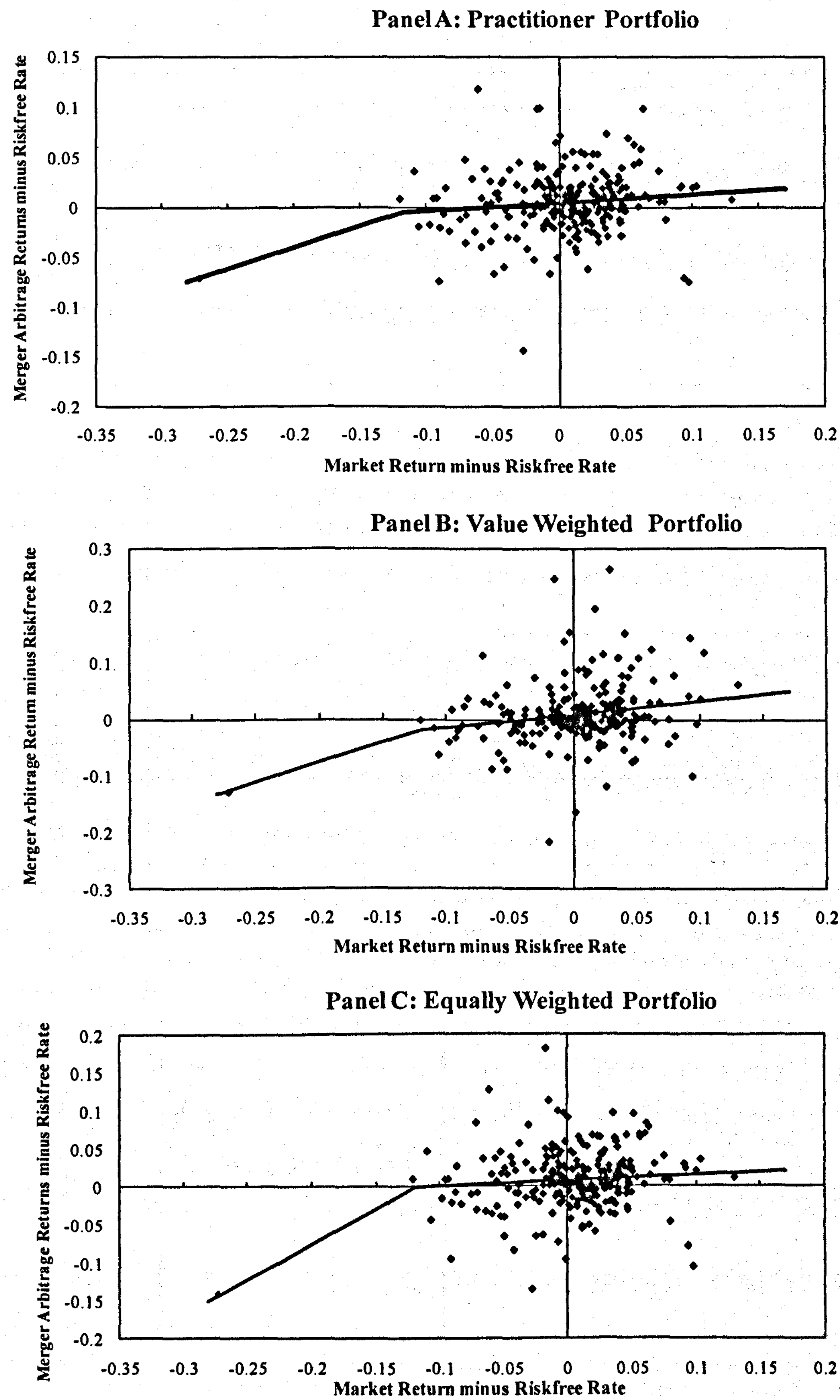

Figure 4.5: Scatter plot of arbitrage return against market return
This figure depicts the merger arbitrage return series against the market return. The fitted line estimated from the piecewise linear model is also plotted

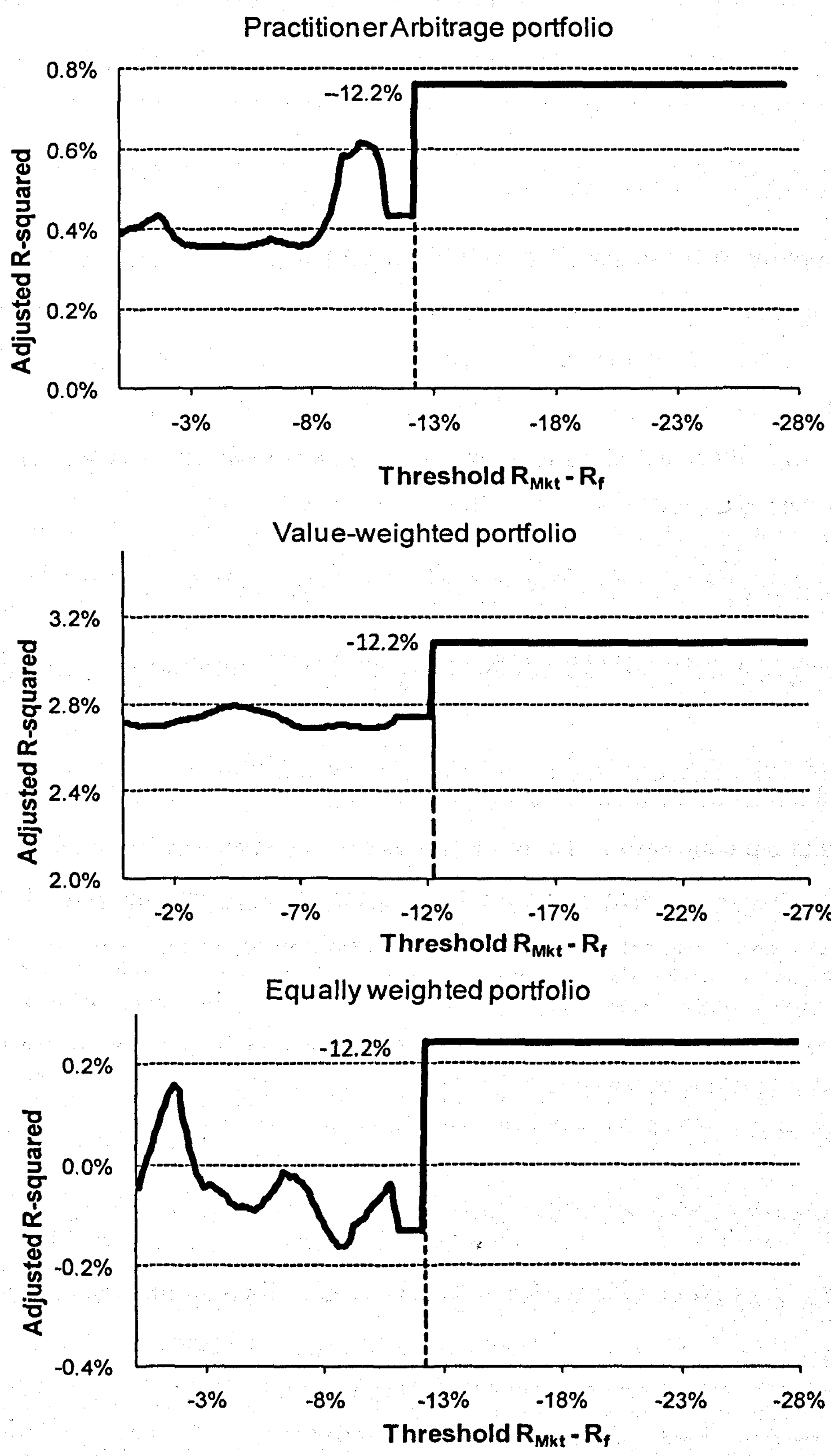

Figure 4.6: Adjusted R-square against market excess return thresholds-subsample
This figure depicts the value of the model's adjusted R-squared against different market excess return thresholds in the piecewise linear regression in equation (19) when the observation corresponding to the October 1987 market crash is removed from the sample.

Chapter 5: LIMITED ARBITRAGE HYPOTHESIS

5.1 Introduction

In Chapter 4, we test the risk-based hypothesis. In doing so, we estimate the return to the merger arbitrage strategy and look at how systematic risk can explain the source of merger arbitrage return. The argument in Chapter 2 points out that under the perfect capital market setting, systematic risk should be the sole determinant of merger arbitrage return. The evidence reported in Chapter 4 tells a different story, nevertheless. We find that the strategy can generate significant positive risk-adjusted return or abnormal return. The result is robust to range of asset pricing models and methods to control for systematic risk. This indicates that systematic risk does not fully explain the return to the strategy. Thus, the risk-based hypothesis can only tell one part of the whole story.

In this and the following chapter, we move away from the perfect capital market setting to identify additional factors other than systematic risk that determine the return to the strategy. In this chapter we test the limited arbitrage hypothesis. Due to market imperfections, the real-world arbitrageurs face different types of risks, costs and constraints in implementing the strategy. These risks, costs and constraints limit the arbitrage activities, hence the name: 'limited arbitrage hypothesis'. We will empirically investigate to what extent these limits to arbitrage can explain the source of merger arbitrage return in the UK market.

As reviewed in section 2.3.2, under the limited arbitrage hypothesis, there are generally two competing theories regarding the source of the abnormal return to the strategy- the part of return that is unexplained by the systematic risk. First, the arbitrage cost theory postulates that the abnormal return exists to compensate the arbitrageurs for bearing the different types of risks and costs. If the arbitrage cost theory holds true, there would be nothing 'abnormal' in the strategy's risk-adjusted return. The arbitrageurs earn fair return commensurate with the additional risks and costs they have to face. Second, the price pressure theory proposes a contrasting view. Based on the agency-based limited arbitrage model developed by Shleifer and Vishny (1997), it is argued that the real world arbitrageurs may be subject to capital constraint. When the arbitrageurs are capital constrained, they might not be able to absorb the selling pressure created by the target shareholders who do not want to bear the deal completion risk. As a consequence, the target stock price might fall well below the efficient level enabling the arbitrageurs to earn abnormal return. Thus, in contrast to the arbitrage cost theory, the price pressure theory suggests that the source of the abnormal return to the strategy is the inefficiency in the pricing of merger stocks.

The extant evidence on the arbitrage cost theory and price pressure theory in the context of merger arbitrage is scanty and inconclusive. In this chapter, we investigate the role of different types of arbitrage costs in explaining the abnormal return to the strategy and perform empirical test of the arbitrage cost theory against the price pressure theory.

Some additional data need to be manually collected. For example, the target large shareholders' ownership and managerial ownership for the bid outcome model described in Chapter 3, the level of the bidder's institutional ownership as a proxy for short-sale constraints. As a result, this chapter employs a smaller sample of takeover bids than the sample for the risk-based hypothesis in Chapter 4. Because the sample is different, we re-estimate the returns in excess of systematic risk for this sample to make sure that the result in Chapter 4 still applies to this sample.

The chapter is structured as followings. Section 5.2 describes the methodology to test the limited arbitrage hypothesis. Section 5.3 discusses the sample selection process and provides some descriptive statistics for the variables. Section 5.4 presents the result of estimating the return to the strategy in excess of systematic risk. Section 5.5 reports the result of the cross-sectional analysis of the abnormal return to the strategy. Section 5.6 summarizes the chapter.

5.2 Methodology

5.2.1 Excess return to individual arbitrage positions

In this chapter, we use cross-sectional analysis to investigate the impact of different types of arbitrage risks and costs on the abnormal return to the merger arbitrage strategy. In doing so, the first step is to estimate the return in excess of systematic risk or abnormal return to each arbitrage position. The portfolio benchmarking procedure employed in Chapter 4 estimates the excess return to the whole portfolio not to each position. Thus, we need a different procedure to estimate the excess return to individual arbitrage positions.

We follow the approach adopted by Baker and Savasoglu (2002). In particular, the return to an arbitrage position in bid i (r_{Ai}) can be decomposed into the return conditional on the bid success r_{Si} and the return conditional on the bid failure r_{Fi}. The model of return to an arbitrage position is:

$$r_{Ai} = \pi_i r_{Si} + (1 - \pi_i) r_{Fi} \tag{21}$$

where π_i is the probability of bid success. To obtain the risk-adjustment benchmark for the return to an arbitrage position, we calculate the benchmark for each return component. The benchmark represents the compensation for systematic risk. As the structures of the investment in stock bids and in cash bids are different, we consider these two types of takeover bids separately.

For stock bids, if the bid goes through, there would be no risk and the arbitrageurs are guaranteed to earn the arbitrage spread. The benchmark for r_{Si} is the risk-free rate. In the event the stock bid fails, the arbitrageur is left with a long position in the target stocks and a short position in the bidder stocks. For an average stock bid, the arbitrage position is approximately market neutral. Mitchell and Pulvino (2001) and the result in Chapter 4 show that the merger arbitrage portfolios of stock bids show little co-movement with the market. As a result, for stock bids, the benchmark return for r_{Fi} is also the risk-free rate r_f. Thus, the risk-adjusted benchmark return for the investment in a stock bid is simply the risk-free rate r_f.

For cash bids, if the bid is successful, the arbitrageurs also face no risk and therefore the benchmark for r_{Si} is the risk-free rate. In case the cash bid fails, the arbitrage position only contains a long position in the target stock and is subject to market-wide movements. Thus, the appropriate benchmark for r_{Fi} is the return to the market portfolio r_M. The risk-adjustment benchmark for the arbitrage position in a cash bid is: $\pi_i r_f + (1-\pi_i) r_M$. The estimation of the probability of bid success π_i is discussed in section 3.4. We use the FTSE All Shares Index as the proxy for the market portfolio and the UK 3-month Government bond rate as the proxy for the risk-free rate.

Using above-mentioned approach to adjust for systematic risk and the method to calculate arbitrage return described in Section 3.3, Chapter 3, we can obtain the daily excess return to the arbitrage investment in each bid. Because the bid duration varies, we focus on the first 30-day compounded excess return, which is calculated using the following equation:

$$ER_{ci}^{30} = \prod_{t=1}^{30} (1 + ER_{it}) - 1 \tag{22}$$

where ER_{ci}^{30} is the 30-day compounded excess return to the arbitrage investment in bid i, ER_i is the daily return in excess of the benchmark to adjust for systematic risk described earlier. When the bid duration is less than 30 day, we first compute the compounded excess return over the duration of the bid then convert the compounded return to 30-day return using the following equation:

$$ER_{ci}^{30} = \frac{ER_{ci} \times 30}{D_i} \quad (23)$$

where ER_{ci} is the compounded excess return for the duration of bid i. D_i is the bid duration, which is the number of days between the bid announcement date and the resolution date. For successful bids, the resolution date is the date on which the bid is declared completed or unconditional as reported in SDC. For failed bids, the resolution date is one day after the date on which the bid is withdrawn. This equation applies when $D_i < 30$.

5.2.2 Research design

Price pressure theory versus Arbitrage cost theory

To test whether the price pressure theory or the arbitrage cost theory provides better description of the source of the excess return to the strategy, we adopt the research design suggested by Baker and Savasoglu (2002). In particular, we estimate the following equation:

$$ER_i^A = \alpha_0 + \alpha_1 \ln\left(TargetSize_i\right) + \sum_{j=2}^{K} \alpha_j X_{ji} + \epsilon_i \quad (24)$$

where ER_i^A is the return adjusted for the systematic risk, or arbitrage abnormal return, to the arbitrage position in bid i. The methodology to estimate ER_i^A is discussed in the previous section. $\ln\left(TargetSize_i\right)$ is the natural logarithm of the market value of the target equity at the bid announcement date in 2007 GBP (hereafter 'target size').) X_{ji} is the set of variables that proxy for different types of arbitrage risks and costs. We will discuss the components of X_{ij} later in this section.

We focus on the relationship between the excess return to the strategy and target size because this relationship helps to differentiate between the price pressure theory and the arbitrage cost theory. Target size proxies for both the selling pressure created by the target shareholders (positive proxy) and transaction costs (negative proxy).

When a takeover bid is announced, the target shareholders face the choice of selling the target stock immediately or holding on to it until the bid is completed to get higher payoff. The later choice however exposes the target shareholders to the risk of bid failure. Even though the risk of bid failure is generally low, the associated loss is usually substantial as target stock price may fall all the way back to the level of 30 to 40 days before the bid is announced. To insure themselves against the possibility of merger 'blow-up', many target shareholders may decide to sell the target stocks shortly after the bid announcement (Weston et al., 2004, ch21), thereby creating a selling pressure. The larger the target size, the larger is the selling pressure.

Under the price pressure theory, as the capital-constrained arbitrageurs may not be able to absorb the selling pressure, the target stock price would fall well below its efficient level generating abnormal profits for the arbitrageurs. The larger the selling pressure, the bigger is the fall in the target stock price. The bigger the fall in the target stock price, the higher is the excess return to the strategy. When target size serves as the proxy for the selling pressure, a positive relationship between excess return and target size should be observed. In equation (24), the price pressure theory would predict that α_1 is positive.

Target size can also be a proxy for the cost of trading in target shares. Firm size is a popular proxy for transaction costs. The shares of large firms tend to be more liquid, have lower bid-ask spread and lower price impact costs (Lakonishok et al., 1994; Pontiff, 1996). As a result, the costs of trading in shares of large firms tend to be lower than for small firms. Pontiff (1996), Gemmill and Thomas (2002) and Bradley, et al. (2010) report that the mispricing in the case of closed-end funds is decreasing in transaction costs proxied by firm size. Ali et al. (2003) use firm size as the proxy for transaction cost in examining the book-to-market anomaly.

Under the arbitrage cost theory, the excess return to the strategy compensates the arbitrageurs for bearing the cost in establishing and maintaining the arbitrage positions. As a result, the higher are the arbitrage costs, the greater is the excess return to strategy. Because target size is inversely related to the cost of trading in target stock, the arbitrage cost theory would predict a negative relationship between the excess return to the strategy and target size. The coefficient α_1 in equation (24) should be negative under the arbitrage cost theory.

Regarding the relationship between the excess return to the merger arbitrage strategy and target size, the prediction of the price pressure theory runs in opposite direction with the prediction of the arbitrage cost theory. This is why target size can be deemed as the key variable to differentiate between the two competing theories.

<u>Other proxies for selling pressure</u>

As an alternative proxy for selling pressure, we use the average abnormal daily trading volume of the target stocks over the period of 3 days, 5 days, and 10 days after the bid announcement date. The following equation is used to estimate the average abnormal daily trading volume:

$$AVOL_{ik} = \frac{1}{k}\sum_{t=+1}^{k} VOL_{it} - 1/119 \sum_{t=-160}^{t=-41} VOL_{it} \qquad (25)$$

where $AVOL_{ik}$ is the average abnormal trading volume of the target stocks over the period of k days after the bid announcement date, VOL_{it} is the daily trading volume of the target stocks at day t. Day 0 is the announcement date. The subscript i refers to bid i in the sample. We measure trading volume in 2007 GBP.

The average abnormal daily trading volume in equation (25) is the difference between average daily trading volume after the bid is announced and the average daily trading volume over a base period. The base period starts at 160 days prior to the bid announcement date and ends at 40 days prior to the bid announcement date so that no information about the bid is factored into the daily trading volume in this period.

If most of the trading after the bid announcement is between the arbitrageurs and the target shareholders (Moore et al., 2005), then the higher the abnormal trading volume, the greater is the selling pressure created by the target shareholders. Hence, when the average abnormal daily trading volume serves as the proxy for selling pressure, a positive relationship between this variable and the excess return to the strategy is expected.

Other proxies for transaction costs

In addition to target size, we also employ three other measures of transaction costs namely the inverse of the stock price level, the dollar trading volume and the frequency of zero return day.

The inverse of stock price level ($InverPrice$)

Stock price levels are found to be inversely related to the quoted bid-ask spread and commission per share (Bhardwaj and Brooks, 1992; Blume and Goldstein, 1992). Copeland and Galai (1983) theoretically demonstrate that the size of the bid-ask spread is negatively related to the stock price level. Stoll and Whaley (1983) find a significant negative relation between the stock price level and firm size, our first proxy for transaction costs. Thus, low share price firms tend to have higher transaction costs than high-share price firm.

We use the inverse of the price level of target stock as the proxy for the cost of trading in target stocks. We measure the price level as the average daily closing price of the target stock over the period of 60 days prior to the bid announcement date. If transaction costs play an important role in determining merger arbitrage return, we should observe a positive relationship between the excess return to strategy and the inverse of the target stock price level.

Dollar trading volume (DollarVol)

We measure the dollar trading volume as the average daily trading volume in 2007 GBP over the period of 160 days prior to the bid announcement date. It is argued that stocks with high dollar trading volume are less prone to price impact effects (Admati and Pfleiderer, 1988; Bhushan, 1991; Kyle, 1985). Spiegel and Wang (2006) report that high dollar trading volume stocks are more liquid and hence have lower transaction costs. Thus, it is expected that the excess return to the strategy are negatively related to dollar trading volume.

Frequency of zero return days (ZeroFreq)

We measure the frequency of zero return days as the percentage of days, in which the target stock has zero return over the period of 160 days prior to the bid announcement date. This measure of transaction costs is developed by Lesmond, et al (1999). If the value of private information possessed by the marginal investors in a trade does not exceed the transaction costs, the investors will reduce trading or not trade resulting in zero return. Therefore, the stocks with greater frequency of zero return days are likely to have higher transaction costs. Ali et al. (2003), Lesmond, et al. (2004) and Duan, et al. (2009) employ the frequency of zero return days as the proxy for transaction costs in their empirical studies. Under the arbitrage cost theory, it is predicted that the relationship between the excess return to strategy and the frequency of zero return days is positive.

Holding cost

While arbitrageurs incur transaction cost only when they open or close the arbitrage position, they face holding cost as long as the position remains open. As the result, the longer the time that the arbitrage position remains open, the greater is the holding cost. In case of merger arbitrage, as the arbitrage position is open until the date the bid is completed or withdrawn, the duration of bid becomes the natural proxy for holding cost. We use bid duration (*Duration*) as the proxy for holding costs in general. We also consider the impact of two specific types of holding costs namely idiosyncratic risk and short-sale constraints.

Idiosyncratic risk

Pontiff (2006) considers idiosyncratic risk the most important type of holding cost. Following Baker and Savasoglu (2002), we use two proxies for the idiosyncratic risk that the merger arbitrageurs have to face.

The first proxy is the variance of the estimated probability ($VarProb$) measured as $\pi_i(1-\pi_i)$, where π_i is the probability that bid i will be completed. The logistic regression model employed to estimate π_i is discussed in Section 3.4, Chapter 3. The variance of the estimated probability of bid success measures the uncertainty about the outcome of the takeover bid. The higher is the variance, the greater is the degree of uncertainty. The variance reaches its maximum value when the estimated probability of bid success gets closer 0.5. In this case, it is very hard to predict the outcome of the bid because the chance that the bid goes through is equal to the chance that the bid fails. The variance reaches its minimum value when estimated probability of bid success gets closer either to 0 or 1. In this case, the uncertainty disappears as the bid is almost sure to fail or succeed.

The second proxy for idiosyncratic risk is bid premium ($Premium$). Bid premium measures the expected losses of the arbitrage investment if the bid fails. In case the bid is called off, the arbitrageurs can lose the entire premium offered by the bidder. Thus, the higher the bid premium, the greater is the downside risk. Similar to Hsieh and Walkling (2005) and Schwert (1996), we measure bid premium as the sum of price run-up and mark-up. The price run-up is the cumulative abnormal return to the target shares for trading days (-40,-1) before the bid announcement date and is calculated using the following equation:

$$Runup_i = \sum_{t=-40}^{t=-1} AR_{it} \tag{26}$$

where $Runup_i$ is the price run-up of the target share in bid i, AR_{it} is the daily abnormal return to the target shares on day t (day 0 is the announcement date). The formula for calculating AR_{it} is:

$$AR_{it} = R_{it}^{T} - \hat{\alpha}_i - \hat{\beta}_i R_{Mt} \tag{27}$$

where R_{it}^{T} is the daily return to the target stocks on day t. R_{Mt} is the return to market portfolio on day t. We use the FTSE All Shares index as the proxy for market portfolio. $\hat{\alpha}$ and $\hat{\beta}$ are the market model parameters. We estimate these parameters by regressing the daily return to the target stocks against the daily return to the market portfolio for trading days (-160, -41).

Mark-up, the second component of bid premium, is computed as $(FP - P_{-1})/P_{-1}$ where P_{-1} is the target stock price one day prior to the bid announcement date and FP is the final offer price.

Short-sale constraints

To establish an arbitrage position in a stock bid, the arbitrageurs need to sell short the bidder stocks. Mitchell et al (2004) report that the arbitrageurs' shorting of bidder stocks is responsible for nearly half of the decline in the price of bidder stocks around the bid announcement date. As a result, the arbitrageurs face short-sale constraints when investing in stock bids. Short selling is costly and risky for three main reasons. First, the short-sellers must pay the lending fees to the stock lenders. Second, the lenders retain the right the recall the stock at any time during the shorting period. Third, the stocks may be not available or in limited supply for lending, which makes short-selling impossible or very costly.

The first constraint, the lending fee, is unlikely to cause much trouble for the arbitrageurs as the fee is generally quite low. D'Avolio (2002) reports that the lending fee in the US is around 0.25% per annum and more than 90% of the stocks lent out cost less than 1% per annum to borrow. According to Thomas (2006), the average lending fee is around 0.14% in the UK and 0.4% in other European markets. The possibility that the shorted stocks are recalled by the lenders, the second constraints, is extremely rare. In the US, less than 2% of the shorted stock are recalled by the lenders in any month (Thomas, 2006).

D'Avolio (2002) argues that it is the third constraint, the limited supply of the stocks for shorting, that makes short selling costly. Using a proprietary dataset to examine the impact of short-sale constraints on the profitability of shorting IPO stocks, DotCom Stocks and of merger arbitrage, Geczy, et al (2002) find that the exclusion of stocks that are not available or in very limited supply for lending substantially reduces the profitability of these strategies while lending fees only have small impact on profitability.

As institutions are the major suppliers of securities for loan (Thomas, 2006), short-sale constraints due to limited supply of lending stocks impact mainly stocks with low institutional ownership. D'Avolio (2002) find that institutional ownership explains more than 50% of the cross-sectional variation in the supply of lending shares. Thus, the level of institutional ownership can be used as a proxy for the short-selling costs. Nagel (2005), Asquith et al (2005) and Ali and Trombley (2006) document that short-sale costs are significantly correlated with the level of institutional ownership.

We use the bidder firm's institutional ownership as the proxy for the short-sale constraints that the arbitrageurs face when shorting the bidder's stocks. The institutional ownership is the percentage of bidder's shares held by institutions, which have interest in 3% or more of the bidder's shares. Under the UK Companies Act 1985, companies are required to disclose in their annual reports the ownership of anyone who has interest in 3% or more of equity shares. Thus, we manually collect the data about institutional ownership from the bidder's most recent annual report prior to the bid announcement. Due to the 3% threshold, the measure of institutional ownership in this study has a downward bias. With the costs of short selling decreasing in the level of institutional ownership, it should be expected that the excess return to the arbitrage investment in stock bids is negatively related to the level of bidder firms' institutional ownership.

Nagel (2005) notes that the level of institutional ownership may be highly correlated with firm size. As we discuss earlier, firm size is a proxy for transaction costs. Thus, for the clean test of the short-sale constraint impacts, the size effects must be controlled for. A simple way to control for size is to include the market value of the bidder firm in the model. In addition to this simple way, we follow Nagel's (2005) approach to purge the size effect from the level of institutional ownership. Under this approach, the residual institutional ownership is used as a proxy for short-sale constraints instead of institutional ownership.

The residual ownership is the residual in the cross-sectional regression, which includes the bidder firm size in the right hand side and the bidder's institutional ownership in the left hand side. For the regression to be well-specified, a logit transformation of the bidders' institutional ownership is performed:

$$logit(Inst_i) = \ln \left(\frac{Inst_i}{1 - Inst_i}\right) \tag{28}$$

where $Inst_i$ is the level of the bidder' institutional ownership in bid i. The values of $Inst_i$ equal to 0 are replaced by 0.0001. The logit transformation maps the level of institutional ownership, which is bounded by 0 and 1, to the real line. After the transformation the following regression is performed:

$$logit(Inst_i) = \kappa_0 + \kappa_1 \ln(AcqSize_i) + \kappa_2[\ln(AcqSize_i)]^2 + \xi_i \qquad (29)$$

where $AcqSize_i$ is the bidder equity market value at the bid announcement date. The square term is included to controll for possible non-linear relationship between institutional ownership and firm size. ξ_i is the error terms of the regression. Residual institutional ownership is the residual of this regression.

The description of all variables used in this chapter is provided in Table 5.1.

[Insert Table 5.1, page 159 here]

5.3 Data and descriptive statistics

5.3.1 Data and sample of takeover bids

The data sources are described in section 3.2.1, Chapter 3. To test the limited arbitrage hypothesis, we have to manually collect data on three variables: the target's managerial ownership and large shareholders' ownership used as the independent variable for the bid outcome model discussed in section 3.4, and the bidder' institutional ownership used as a proxy for short-sale constraints in this chapter. The data are obtained from the company annual reports available in Perfect Filings. As this database provides little coverage prior to 1995 and due to the heavy demand in terms of labour for the data collection process, the empirical tests in this chapter employ a smaller sample of takeover bids than the sample employed in the Chapter 4 testing the risk-based hypothesis. The sample selection process is described in Section 3.2.2, Chapter 3. This sample includes 653 UK cash and stock bids from 1997 to 2007.

Table 5.2 presents the summary statistics for the sample. Around 80% of the bids in the sample are paid for in cash. For both stock and cash bids, the mean of the transaction value is much larger than the median implying that there are a few very large deals in the sample that skew the distribution of the variable. The success rate, the percentage of the bids that finally go through, is 82% and varies considerably throughout the sample period. Over the sample period the success rates of cash bid is generally greater than the success rates of stock bids. The t-statistic of 2.03 of the paired comparison test for the difference between the success rates of cash bids and the success rates of stock bids confirms this fact.

[Insert Table 5.2, page 161 here]

5.3.2 Descriptive statistics and univariate analysis

Table 5.3 presents the descriptive statistics for all variables described in Section 5.2. We divide the samples into 2 subsamples. The first subsample includes observations with excess return greater than the median excess return (the high excess return subsample) and the second subsample contains the remaining observations (the low excess return subsample). Descriptive statistics for all variables in these two subsamples as well as the result of the tests for the difference in mean and median between these subsamples are reported. These simple univariate tests provide the initial idea about the impact of difference types of arbitrage risks, costs and constraints on the excess return to the strategy.

[Insert Table 5.3, page 162 here]

The results of the univariate tests provide little conclusive evidence about the impact of arbitrage risks and costs as only 3 tests show statistically significant results. First, the target size of the high excess return subsample is lower than the target size of the low excess return subsample. This negative relation between target size and excess return provides support for the arbitrage cost theory because the costs of trading in stocks of large target firm are generally lower than the costs of trading in small target firms. This negative relationship also invalidates the price pressure theory as this theory predicts a positive relationship between target size and excess return.

Second, price level of target stocks is found to be negatively related to the excess return to the strategy. Again, this finding indicates that transaction cost is an important determinant of merger arbitrage return. Stocks with low price level typically have higher transaction costs. The arbitrageurs facing with high transaction costs will require higher expected returns to compensate for the costs.

Finally, premium is greater for the high excess return subsample than for the low excess return subsample. As premium is the proxy for the expected losses the arbitrageurs may incur when the bid fails, this result is consistent with the impact of idiosyncratic risk. The excess return to the strategy is increasing in the level of idiosyncratic risk.

The tests on the remaining variables show insignificant results. We will have a different picture in the multivariate tests in Section 5.5.

5.4 Benchmarking the portfolio return

Because in this chapter we use a different sample from the sample used in Chapter 4 testing the risk-based hypothesis, to make sure that the result in Chapter 4 still holds for this sample we estimate the risk-adjusted return to the merger arbitrage portfolios constructed on this new sample. It is noted that the empirical test of the limited arbitrage hypothesis is interesting only because the merger arbitrage portfolio can persistently generate positive return in excess of the compensation for systematic risk. The portfolio construction process follows the procedure described in Section 4.3.2. Following this procedure, three arbitrage return series are constructed: the Practitioner Arbitrage portfolio, the value weighted arbitrage portfolio and the equally-weighted arbitrage portfolio.

Figure 5.1 plots the number of active bids in a month for the merger arbitrage portfolios over the sample period. The number of bids in each month varies considerably and exhibits a clustering pattern through time. The number of active bids is high for some periods, for instance 1998- 2001, and is low for the others, for example 2002-2004. This pattern is consistent with the fact that mergers tend to occur in waves (Sudarsanam, 2003).

[Insert Figure 5.1, page 170 here]

Figure 5.2 depicts the value over the sample period of £1 investment in the three arbitrage portfolios, the market portfolio, and risk-free bond starting from 01/01/1997. On 31/12/2007, the investment in the PA portfolio grows into £4.67 but the investment in the market portfolio only translates into £2.25. The investment in other two arbitrage return series also outperforms the market portfolio. These initial descriptive statistics indicates that the merger arbitrage strategy appears to perform well in the UK market.

[Insert Figure 5.2, page 171 here]

We employ three asset pricing models to estimate the portfolio's risk-adjusted return over the sample period, that is, the Capital Asset Pricing Model (CAPM), Fama and French (1993) three-factor model, and Carhart (1997) four-factor model:

CAPM:

$$R_t^A - R_t^f = \alpha + \beta_M\left(R_t^M - R_t^f\right) + \epsilon_t \tag{30}$$

Fama and French (1993) three-factor model:

$$R_t^A - R_t^f = \alpha + \beta_M\left(R_t^M - R_t^f\right) + \beta_{SMB}SMB + \beta_{HML}HML + \xi_t \tag{31}$$

Carhart (1997) four-factor model:

$$R_t^A - R_t^f = \alpha + \beta_M\left(R_t^M - R_t^f\right) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{UMD}UMD + \upsilon_t \tag{32}$$

where R_t^A is the monthly return to the merger arbitrage portfolios on month t, R_t^f is the monthly risk-free rate, R_t^M is the monthly return to the market portfolio. In this study, we measure risk-free rate using three-month UK Government bond, and use the FTSE All Share index as the proxy for market portfolio. SMB is the difference in return between a portfolio of small stocks and a portfolio of big stocks, HML is the difference in return between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. UMD is the difference in return between a portfolio of stocks with high past return and a portfolio of stocks with low past return. The construction of HML and SMB factor for the UK market is similar to the approach adopted by Daniel, Titman and Wei (2001). The construction of HML, SMB and UMD for the UK market follows Liew and Vassalou (2000). β is the systematic risk associated with different risk factors and is estimated with the data. ϵ_t, ξ_t, and v_t are the error terms of the models. The intercept α measures the average monthly risk-adjusted return or abnormal return. Based on the results from existing studies we expect that α is significantly positive. We report the estimation of the risk-adjusted return to three merger arbitrage return series in Table 5.4.

[Insert Table 5.4, page 163 here]

The abnormal return to the Practitioner Arbitrage portfolio and the equally-weighted portfolio is positive and statistically significant at 1% level when these three models are employed as the risk-adjustment benchmark. As for the value-weighted portfolio, the estimated abnormal return is positive but statistically insignificant when CAPM and Fama and French (1993) three-factor model are used to control for risk. The abnormal return for the value-weighted return series becomes statistically significant in case Carhart (1997) four-factor model serves as the risk-adjustment benchmark. The result is in generally consistent with the extant studies and with the result in Chapter 4 about the risk-based hypothesis. Systematic risk can only partially explain the returns to the merger arbitrage strategy. The persistence of positive abnormal return requires further explanation about their source. This is what we are attempting in this chapter.

The finding that the abnormal return to the value weighted portfolio is statistically insignificant when CAPM and Fama and French (1993) model are employed as the risk-adjustment benchmark shows some favour for the arbitrage cost theory. The return to the investment in large targets has more weight in the value-weighted portfolio. As the argument in Section 5.2.2 points out, the arbitrageurs incur smaller transaction costs when trading in the stocks of large target firms. The arbitrage cost theory would, therefore, predict that the abnormal return to the arbitrage positions in takeover bids with large target firms is smaller than the abnormal return in takeover bids with small target firms. As a result, under the arbitrage cost theory, the abnormal return to the value-weighted portfolio may be smaller than the abnormal return to the PA portfolio and the abnormal return to the equally-weighted portfolio. A weaker supportive evidence for the fact that the value-weighted portfolio can generate positive abnormal return is consistent with the arbitrage cost theory. In the next section we will perform formal empirical tests of the arbitrage cost theory.

5.5 Cross-sectional determinants of merger arbitrage excess return

In this section, we employ cross-sectional regression to investigate the impact of different types of risks and costs on the excess return to the strategy. The dependent variable of the regression is the excess return to each individual arbitrage position. Because the bid duration varies, we focus on the first 30-day compounded excess return. Our approach is similar to Baker and Savaloglu (2002). The result is qualitatively the same if we focus on different event windows or use annualized excess return. The independent variables are the ones described in Section 5.2.2. The estimation of the cross-sectional regression is presented in Table 5.5

[Insert Table 5.5, page 165 here]

We discuss the cross-sectional result following the structure outlined in Section 5.2.2. First, we look at the test that helps differentiate between two competing theories under the limited arbitrage hypothesis, that is, the arbitrage cost theory and the price pressure theory.

5.5.1 Transaction Costs versus Price Pressure

Target size

The discussion in Section 5.2.2 points out that the key variable that helps differentiate between the arbitrage cost theory and the price pressure theory is target size. These two competing theories propose contrasting predictions regarding the relationship between the excess return to the strategy and target size. The relationship is predicted to be positive under the price pressure theory but negative under the arbitrage cost theory.

The result presented in model (1) of Table 5.5 provides strong support for the arbitrage cost theory and at the same time refute the price pressure theory. The excess return is negatively related to size of the target and the relationship is statistically significant at 1% level. To ensure that our result is not driven by outliers as the descriptive statistics in Section 5.3.2 show that the distribution of target size might be skewed toward a few very large deals (mean is much larger than median), we perform additional analysis. In particular, we replace target size with the dummy variable $LargeDeal$, which is equal to 1 if the bid is in the top decile of the target equity market value at the bid announcement date, and 0 otherwise. The result in model (2) of Table 5.5 confirms the negative relationship between the arbitrage excess return and target size. The coefficient estimate of $LargeDeal$ is negative and statistically significant at 1% level. The excess returns to the investment in those bids with the largest targets are on average 3.6% lower than the excess returns to the investment in other bids.

The result clearly shows that selling pressure has little impact on the pricing of merger stocks. The marginal investors in the merger arbitrage game appear to care more about transaction costs when determining the price of merger stocks. As investing in large targets involves smaller transaction costs, the negative relationship shows that the transaction costs seem to be one of the primary drivers of the cross-sectional variation in the merger arbitrage abnormal return.

Other measures of price pressure

The result about the relationship between the arbitrage excess return and target size seems to refute the price pressure theory. To ensure that the result is not driven by the poor proxy for selling pressure, we perform additional tests on other selling pressure proxies. The direct measure of selling pressure should be sell-initiated trading volume, which requires market microstructure data to estimate. As we do not have access to such data, we use the average abnormal trading volume as the alternative proxy for selling pressure. To the extent that much of the surge in the trading volume after the bid is announced is caused by target's shareholders' selling to arbitrageurs, abnormal trading volume is good proxy for selling pressure. Under the price pressure theory, arbitrage excess return is positively related to the abnormal trading volume.

The result in model (3), (4) and (5) of Table 5.5 shows the opposite nevertheless. 3-day, 5-day, and 10-day average daily abnormal trading volume are all found to be negatively related to the arbitrage excess return and the relationship is even statistically significant at 5% level. Thus, we find no support for the price pressure theory.

Other measures of transaction costs

In addition to target size, in this chapter we also examine the relationship between excess return and three other proxies for transaction costs namely the inverse of the stock price level, dollar trading volume and frequency of zero-return days. The result is reported in model (6) to (9) of Table 5.5.

When the cross-sectional regression includes only one proxy at a time, the coefficient estimate is statistically significant at 1% level and has the sign that is consistent with the arbitrage cost theory. Stocks with low price level or high frequency of zero return days have high transaction costs. Thus, the observed positive relationship between the inverse of the target stock price level, frequency of zero returns days and the arbitrage excess return indicates that transaction costs are an important determinant of the return to strategy. As for dollar trading volume, because this variable is negatively related to transaction costs, a negative relationship between the arbitrage excess return and dollar trading volume supports the arbitrage cost theory.

In model (9) of Table 5.5, we put all 4 proxies for the costs of trading in target stocks into the regression. As can be seen, only target size and the inverse of target stock price level are statistically significant. The other two proxies lose their explanatory power when considered with other proxies for transaction costs.

The findings in this section clearly show that the arbitrage cost theory dominates the price pressure theory in explaining the cross-section variation of the excess return to the strategy. There is no supporting evidence for the price pressure theory. Transaction costs appear to be an important determinant of merger arbitrage return. The higher is the costs of trading in the target stocks, the higher is the excess return to the strategy. The relationship between transaction costs and arbitrage return is robust to a range of proxies for transaction costs.

5.5.2 Holding costs

In the previous section, we test whether transaction cost or selling pressure provides better description of the cross-section variation of the arbitrage excess return. We find that transaction costs are the dominant determinant of the return to the strategy. As argued in Section 5.2.2, transaction costs are one of the two major types of costs and risks that the real-world arbitrageurs have to face. The other type is holding costs. While transaction costs are incurred only when the position is opened or closed, holding costs are cost per unit of time meaning that the arbitrageurs face holding costs as long as the arbitrage position remains open. In this section, we examine the impact of holding costs on the arbitrage excess return.

In merger arbitrage, because the arbitrageurs need to hold on to the arbitrage position until the bid is consummated or terminated, the bid duration can serve as a natural proxy for holding costs in general. The arbitrage cost theory would predict a positive relationship between the excess return to strategy and bid duration. The result in Table 5.5 confirms the impact of holding costs. In all models, bid duration is found to be positively related to the excess return to the strategy. Next, we discuss the result of the tests for the impact of two specific types of holding costs, that is, idiosyncratic risk and short-sale constraints.

Idiosyncratic risk

The results in Table 5.5 show strong support for impact of idiosyncratic risk. As expected, both proxies for idiosyncratic risk, the variance of the estimated probability of bid success and bid premium, are positively related to the arbitrage excess return and the relationship is statistically significant at 1% level.

The variance of the estimated probability of bid success increases when the probability of bid success gets closer to 0.5 and decreases when the probability of bid success moves toward 0 or 1. When the probability of bid success is in the vicinity of 0.5, it is difficult to assess the outcome of the bid because the chance that the bid goes through is about the same as the chance that the bid fails. Thus, the uncertainty regarding the bid outcome is highest when the probability of bid success approaches 0.5. The positive relationship between the excess return and the variance of the estimated probability of bid success indicates that excess return increases with the level of uncertainty about the bid outcome. The arbitrageurs require higher expected return to compensate for the uncertainty.

The level of uncertainty regarding the bid outcome is one dimension of the idiosyncratic risk the arbitrageurs have to face. Another dimension is the expected losses if thing goes wrong. In the context of merger arbitrage, the higher the bid premium, the bigger is the expected losses on the arbitrageurs' part if the bid fails. This dimension of risk also behaves consistently with the uncertainty dimension. The excess return to the merger arbitrage strategy is positively related to bid premium. Overall, the finding shows that the higher is the level of idiosyncratic risk, the higher is the arbitrage excess return to compensate the arbitrageurs for the risk.

The risks and costs examined so far are applied equally to cash bids and stock bids. We repeat the empirical test in Table 5.5 to the subsample of cash bids and the result is very similar. The result for the subsample of cash bids is reported in Table 5.6. For stock bids, the arbitrageurs face another type of holding costs, that is, short-sale constraints, which will be examined next.

[Insert Table 5.6 here, page 167]

Short-sale constraints

As the arbitrage investment in stock bids includes a short position in the bidder stocks, the arbitrageurs face short-sale constraints when investing in stock bids. To investigate the impact of short-sale constraints, we estimate the cross-section regression that includes the level of bidder's institutional ownership, the proxy for the short-selling costs, in the right hand side of the model. To take into account the impact of transaction costs and idiosyncratic risk, we also include other variables that proxy for these costs and risk in the regression. The argument in Section 5.2.2 shows that it is necessary to control for the bidder firm size in order to have a 'clean test' for the impact of short sale constraint. To purge the size effect, we include the bidder market value in the regression. Alternatively, we use the residual institutional ownership, which is a measure free of the size effect, in place of the bidder's institutional ownership. The detail of how to obtain the residual ownership is described in Section 5.2.2. As the short-sale constraints impose only on the investment in stock bids, we employ only a subsample of stock bids to estimate the regression. The regression result is reported in Table 5.7.

[Insert Table 5.7 *here, page 169]*

The results about the impact of transaction costs, holding costs in general and idiosyncratic risk for the subsample of stock bids are similar to the results for the whole sample and for the subsample of cash bids in Table 5.5 and Table 5.6 respectively. However, only a few coefficient estimates are statistically significant. This may be the consequent of the small sample size. The size of the subsample of stock bids is only 123 observations and even down to 102 in 2 regressions (model (2) and (7) of Table 5.7). Due to the small sample size, the standard errors of coefficient estimates will be large resulting in the insignificant results. Thus, we should be cautious in interpreting the results based on statistical significance for this subsample of stock bids.

As far as the impact of short-sale constraints is concerned, both the level of the bidder's institutional ownership and residual institutional ownership are found to be negatively related to the arbitrage excess return. Since the short-selling costs are generally smaller for stock with high level of institutional ownership, the result shows that the arbitrage excess return increases with the size of short-selling costs. This finding indicates that short-selling costs deter the arbitrageurs from competing away the excess return to the merger arbitrage strategy. The arbitrageurs facing short-sale constraints demand higher return to compensate for these risks and costs.

As noted earlier, caution should be taken in interpreting the impact of short-sale constraint as both proxies for short-sale constraints are statistically insignificant. This might be the direct consequence of the small sample size but may also reflect the true relationship between short-sale constraints and excess return. Thus, for this sample, the impact of short-sale constraint is at best inconclusive.

In summary, holding costs appear to contribute significantly to the source of the merger arbitrage return. The arbitrage excess return is found to increase with bid duration, the proxy for holding costs in general. Also, arbitrageurs facing with idiosyncratic risk also require a high level of return to compensate for the risk. Finally, we find that short-sale constraints may be another important determinant of the excess return. Due to the small size of the stock bid sample, the impact of short-sale constraint is still inconclusive.

5.6 Chapter summary

This chapter performs empirical tests on the two competing theories under the limited arbitrage hypothesis namely the price pressure theory and the arbitrage cost theory. These two theories propose contrasting explanations about why the return in excess of the benchmark for systematic risk or abnormal return persists. The price pressure theory postulates that the real-world arbitrageurs are likely to be capital constrained and might not be able to absorb the selling pressure created by the target shareholders who do not want to bear the deal completion risk. As a consequence, the target stock price may fall well below its inefficient level enabling the arbitrageurs to earn abnormal return. Thus, under the price pressure theory, the source of the arbitrage excess return is the inefficiency in the pricing of merger stocks. The arbitrage cost theory, by contrast, proposes that positive excess return exists because the real-world arbitrageurs have to face different types of risks and costs other than systematic risk. The excess return compensates the arbitrageurs for bearing these additional risks and costs. In the spirits of the arbitrage cost theory, there is no inefficiency in the pricing of merger stocks. The arbitrageurs earn a fair return commensurate with the risks and costs that they have to face.

The findings of this chapter show very little support for the price pressure theory. Using a range of proxies for price pressure and transaction costs, we find that the transaction costs effect dominates the price pressure effect. The differences in the transaction costs that the arbitrageurs incur appear to be one of the important forces behind the cross-sectional variation of the merger arbitrage abnormal return. As transaction costs are one type of arbitrage costs that the arbitrageurs have to face, this result is consistent with the arbitrage cost theory.

The other type of arbitrage costs namely holding costs is found to have significant impact on the arbitrage excess return. Idiosyncratic risk, one of the most important holding costs, significantly contributes to the source of the arbitrage return. Excess return increases with the level of idiosyncratic risk as the arbitrageurs require higher return to compensate for the risk. Finally, we find that short-sale constraints appear to be another important holding cost that the arbitrageurs concern about. Due to the small sample size, the impact of short-sale constraints is still inconclusive nevertheless.

Since the theoretical foundation of the price pressure theory is the agency-based limited arbitrage model proposed by Shleifer and Vishny (1997), the failure of the price pressure theory in explaining the cross-sectional determinants of the merger arbitrage abnormal return may stem from the invalidity of the model's assumption. The model assumes that the outside investors do not understand the opaque nature of the merger arbitrage strategy, which in turn leads to the constraints on the arbitrageurs' capital. As argued by Officer (2007), this assumption seems rather tenuous. As the main players in the merger arbitrage game are hedge funds, who get capital mainly from sophisticated investors, it is unlikely that the outside investors are completely unaware of the nature of the strategy. Furthermore, the parties involving in mergers and acquisitions are required, by the laws, to disclose a fair amount of information about the deal. Thus, it is easy for the outside investors to be informed about the deal. As the information disclosure requirements are even stricter in the UK context compared to the US (Kenyon-Slade, 2004; Sudarsanam, 2003), the model's assumption is even weaker in our study. This may help explain why we find no support for the price pressure theory in the UK context. In the next section, we will see in greater detail the impact of the stricter disclosure requirement in the UK on the merger arbitrage activities.

Table 5.1: Description of variables used in the limited arbitrage hypothesis

Variable name	Description	Data source
ER^A	ER^A is the return adjusted for the systematic risk, or arbitrage abnormal return, to the arbitrage position in each bid	SDC, Datastream
$TargetSize$	$TargetSize$ is the target equity market value in 2007 GBP	Datastream
$AVOL3$, $AVOL5$, $AVOL10$	$AVOL3$, $AVOL5$, and $AVOL10$ are the average daily abnormal trading volume in 2007 GBP over the period of 3 days, 5 days, and 10 days respectively after the bid announcement date. The average daily abnormal trading volume is the difference between average daily trading volume after the bid is announced and the average daily trading volume over a base period. The base period starts at 160 days prior to bid announcement date and ends at 40 days prior to the bid announcement date.	Datastream
$InverPrice$	$InverPrice$ is the inverse of the price level of target stock. The price level is the average daily closing price of the target stock over the period of 60 days prior to the bid announcement date	Datastream
$DollarVol$	$DollarVol$ is the dollar trading volume measured as the average daily trading volume in 2007 GBP over the period of 160 days prior to the bid announcement date	Datastream
$ZeroFreq$	$ZeroFreq$ is the frequency of zero return days measured as the percentage of days, in which the target stock has zero return over the period of 160 days prior to the bid announcement date.	Datastream
$Duration$	$Duration$ is the duration of the takeover bid measured as the number of days between the bid announcement date and the date on which the bid is completed or withdrawn.	SDC
$Premium$	$Premium$ is the bid premium measure as the sum of runup and markup. Runup is the cumulative abnormal return to the target shares for trading days (-40,-1) before the bid announcement date. Markup is	SDC, Datastream

	computed as $(FP - P_{-1})/P_{-1}$ where P_{-1} is the target stock price one day prior to the bid announcement date and FP is the final offer price	
$VarProb$	$VarProb$ is the variance of the estimated probability measured as $\pi_i(1-\pi_i)$, where π_i is the probability that bid i will be completed.	SDC, Datastream
$Inst$	$Inst$ is the bidder's institutional ownership measured as the percentage of the bidder's shares held by institutions.	Perfect Filings, SDC
$AcqSize$	$AcqSize$ is the bidder equity market value at the bid announcement date	Datastream
$ResInst$	$ResInst$ is the residual institutional ownership obtained as the residuals in the regression in which the bidder' institutional ownership is the dependent variable and the bidder firm size is the independent variable.	Datastream

(Note: We use the UK Consumer Price Index – All Urban: All items to convert value to 2007 GBP)

Table 5.2: Sample Description

This table presents a summary of the takeover bid sample used in this chapter. Only pure cash and pure stock\mergers are included. The transaction value in GBP is recorded in SDC. Success rate is the percentage of the transactions reported as "completed" or "unconditional" in SDC over total number of transactions. For transaction value, the figure in the parentheses is median, the other one is mean. The transaction values in different years are converted to 2007 value using the *UK Consumer Price Index – All Urban: All items.*

Year	Cash Mergers			Stock Mergers		
	Number of Deals	Average Value (£ millions)	Success Rate	Number of Deals	Average Value (£ millions)	Success Rate
1997	27 (64.29%)	210.95 (72.59)	92.59%	15 (35.71%)	66.16 (44.30)	86.67%
1998	42 (68.85%)	110.24 (31.29)	92.86%	19 (31.15%)	616.61 (127.16)	78.95%
1999	76 (76.77%)	204.64 (37.12)	94.74%	23 (23.23%)	356.51 (34.19)	86.96%
2000	54 (75.00%)	288.96 (70.13)	87.04%	18 (25.00%)	659.01 (71.21)	88.89%
2001	23 (74.19%)	223.80 (37.40)	100.00%	8 (25.81%)	18.89 (17.12)	87.50%
2002	24 (85.71%)	77.84 (19.71)	95.83%	4 (14.29%)	364.80 (418.57)	100.00%
2003	52 (85.25%)	172.63 (39.20)	98.08%	9 (14.75%)	60.53 (31.27)	100.00%
2004	27 (81.82%)	275.31 (83.45)	88.89%	6 (18.18%)	74.96 (23.55)	100.00%
2005	60 (88.24%)	399.57 (88.73)	90.00%	8 (11.76%)	70.15 (49.27)	75.00%
2006	91 (88.35%)	831.08 (99.95)	85.71%	12 (11.65%)	171.84 (95.55)	75.00%
2007	51 (92.73%)	716.19 (91.31)	90.20%	4 (7.27%)	1,114.45 (146.99)	75.00%
Complete Sample	527 (80.70%)	381.47 (53.40)	91.46%	126 (19.30%)	336.95 (40.08)	85.71%

Table 5.3: Descriptive statistics of limited arbitrage variables

This table presents the descriptive statistics of all variables that proxy for different types of arbitrage risk and costs. All variables are defined in Table 5.1. The statistics are reported for the whole sample and for two subsamples. The first subsample includes observations with excess return greater than the median excess return and the other includes the remaining observations. The result of the tests for the difference in mean and median between these two subsamples is also reported.

Variable	All	High excess return	Low excess return	Difference
	Mean [Median]	Mean [Median]	Mean [Median]	Mean [Median]
TargetSize (£2007 million)	377.6529	367.0388	388.2346	-21.1958
	[59.1347]	[48.3708]	[73.1860]	[-24.8151]**
AVOL3 (£2007 thousand)	888.4999	971.3913	812.9391	158.4522
	[84.5644]	[88.9493]	[82.6203]	[6.329]
AVOL5 (£2007 thousand)	420.9315	480.0958	366.9817	113.1141
	[43.6850]	[47.5692]	[42.1779]	[5.3913]
AVOL10 (£2007 thousand)	147.3897	167.6632	128.9030	38.7602
	[18.5476]	[20.4573]	[17.3227]	[3.1346]
PriceLevel (pence)	161.2627	158.6052	163.9122	-5.307
	[94.9672]	[75.7828]	[102.5902]	[-26.8074]**
DollarVol (£2007 thousand)	1,029.0560	1,049.3890	1,010.1510	39.238
	[189.9276]	[199.2153]	[183.8597]	[15.3556]
ZeroFreq	0.5221	0.5314	0.5128	0.0186
	[0.5813]	[0.6031]	[0.5625]	[0.0406]
VarProb	0.0981	0.1002	0.0960	0.0042
	[0.0776]	[0.0769]	[0.0779]	[-0.001]
Premium	0.3109	0.3705	0.2515	0.119***
	[0.2299]	[0.2754]	[0.1927]	[0.0827]***
Inst	0.3495	0.3553	0.3438	0.0115
	[0.3334]	[0.3408]	[0.3160]	[0.0248]
ResInst	0.0000	-0.1748	0.1719	-0.3467
	[0.4212]	[0.5050]	[0.3280]	[0.1769]

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 5.4: Benchmarking merger arbitrage return series with linear pricing models

This table presents the result when the return to merger arbitrage portfolio is benchmarked against Capital Asset Price Model (CAPM), Fama and French (1993) three-factor model (F&F), and Carhart (1997) four-factor model (C4):

CAPM: $$R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \epsilon_t \quad (30)$$

F&F: $$R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \beta_{SMB}SMB + \beta_{HML}HML + \xi_t \quad (31)$$

C4: $$R_t^A - R_t^f = \alpha + \beta_M(R_t^M - R_t^f) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{UMD}UMD + \upsilon_t \quad (32)$$

where R_t^A is the monthly return to the merger arbitrage portfolios, R_t^f is the risk-free rate, R_t^M is the return to the market portfolio. We measure risk-free rate using three-month UK Government bond, and use FTSE All share index as the proxy for the market portfolio. SMB is the difference in return between a portfolio of small stocks and a portfolio of big stocks, HML is the difference in return between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. UMD is the difference in return between a portfolio of stocks with high past return and a portfolio of stocks with low past return. β is the systematic risk associated with different risk factors. The intercept α measures the average monthly risk-adjusted returns. ϵ_t, ξ_t, and υ_t are the error terms of the models. Newey and West (1987) heteroskedasticity and autocorrelation consistent standard error of the coefficient estimates is reported in the parenthesis.

Dependent Variables	α	β_M	β_{SMB}	β_{HML}	β_{UMD}	Adj.R^2	Sample Size
Panel A: Capital Asset Pricing Model (CAPM)							
Practitioner portfolio return	0.0076***	0.0863*				0.0147	132
	(0.0021)	(0.0468)					
Value weighted portfolio return	0.0050	0.1354**				0.0192	132
	(0.0030)	(0.0673)					
Equally Weighted portfolio return	0.0077***	0.0636				0.0005	132
	(0.0026)	(0.0543)					

Dependent Variables	α	β_M	β_{SMB}	β_{HML}	β_{UMD}	Adj.R^2	Sample Size
Panel B: Fama and French (1993) three-factor model							
Practitioner portfolio return	0.0078***	0.0937*	0.0550	-0.0233		0.0129	132
	(0.0022)	(0.0544)	(0.0571)	(0.0799)			
Value weighted portfolio return	0.0046	0.1837**	0.1867***	0.0563		0.0431	132
	(0.0031)	(0.0788)	(0.0692)	(0.1008)			
Equally Weighted portfolio return	0.0088***	0.0377	-0.0145	-0.1345		0.0016	132
	(0.0027)	(0.0610)	(0.0688)	(0.1024)			
Panel C: Carhart (1997) four-factor model							
Practitioner portfolio return	0.0102***	-0.0019	-0.0591	-0.2626***	0.0121	0.0728	132
	(0.0022)	(0.0528)	(0.0541)	(0.0823)	(0.0904)		
Value weighted portfolio return	0.0086**	0.0346	-0.0106	-0.3316***	-0.1064	0.0766	132
	(0.0034)	(0.0756)	(0.0676)	(0.1160)	(0.1247)		
Equally Weighted portfolio return	0.0105***	-0.0405	-0.0919	-0.3020***	0.0766	0.0559	132
	(0.0025)	(0.0652)	(0.0672)	(0.0954)	(0.1162)		

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 5.5: Cross-sectional determinants of arbitrage abnormal return – whole sample

This table presents the result of the cross-sectional determinants of merger arbitrage abnormal return for the whole sample of takeover bids. Except for $LargeDeal$, all variables are described in Table 5.1. $LargeDeal$ is the dummy variable that is equal to 1 if the bid is in the top decile of the target equity market value at the bid announcement date. The figures in the parentheses are the heteroskedasticity-consistent standard errors of the coefficient estimates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	-0.0454	-0.0727**	-0.0639*	-0.0611*	-0.0606*	-0.0593*	-0.0675*	-0.1046***	-0.0421
	(0.0319)	(0.0328)	(0.0350)	(0.0347)	(0.0349)	(0.0327)	(0.0346)	(0.0379)	(0.0453)
ln(TargetSize)	-0.0115***								-0.0114**
	(0.0028)								(0.0046)
LargeDeal		-0.0358***							
		(0.0103)							
VarProb	0.2508***	0.1795***	0.1313**	0.1324**	0.1292**	0.1423***	0.1426**	0.1991***	0.2281***
	(0.0649)	(0.0585)	(0.0587)	(0.0589)	(0.0582)	(0.0529)	(0.0599)	(0.0591)	(0.0700)
Premium	0.0402***	0.0432***	0.0445***	0.0445***	0.0444***	0.0449***	0.0455***	0.0421***	0.0413***
	(0.0139)	(0.0138)	(0.0154)	(0.0154)	(0.0154)	(0.0148)	(0.0153)	(0.0139)	(0.0156)
ln(Duration)	0.0171**	0.0142*	0.0122	0.0115	0.0114	0.0105	0.0128	0.0145*	0.0178**
	(0.0080)	(0.0078)	(0.0085)	(0.0085)	(0.0085)	(0.0079)	(0.0084)	(0.0081)	(0.0087)
AVOL3 ($x10^{-3}$)			-0.0021**						
			(0.0010)						
AVOL5 ($x10^{-3}$)				-0.0048**					
				(0.0021)					
AVOL10 ($x10^{-3}$)					-0.0112**				
					(0.0052)				
InverPrice						0.0298***			0.0211***
						(0.0041)			(0.0055)
DollarVol ($x10^{-3}$)							-0.0027***		-0.0006
							(0.0010)		(0.0011)
ZeroFreq								0.0487***	-0.0137
								(0.0155)	(0.0235)
N	653	653	562	564	564	653	577	653	577
Adjusted R^2	0.0863	0.0628	0.0518	0.0519	0.0510	0.0600	0.0586	0.0666	0.0873

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 5.6:: Cross-sectional determinants of arbitrage abnormal return – cash sample

This table presents the result of the cross-sectional determinants of merger arbitrage abnormal return for the subsample of cash bids. Except for $LargeDeal$, all variables are described in Table 5.1. $LargeDeal$ is the dummy variable that is equal to 1 if the bid is in the top decile of the target equity market value at the bid announcement date. The figures in the parentheses are the heteroskedasticity-consistent standard errors of the coefficient estimates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	-0.0481	-0.0756**	-0.0828**	-0.0789**	-0.0785**	-0.0656*	-0.0788**	-0.1112***	-0.0540
	(0.0334)	(0.0345)	(0.0368)	(0.0366)	(0.0366)	(0.0344)	(0.0358)	(0.0398)	(0.0456)
ln(TargetSize)	-0.0128***								-0.0120**
	(0.0032)								(0.0051)
LargeDeal		-0.0356***							
		(0.0117)							
VarProb	0.2672***	0.1868***	0.1242**	0.1246**	0.1211*	0.1528**	0.1352**	0.2085***	0.2215***
	(0.0733)	(0.0666)	(0.0629)	(0.0634)	(0.0624)	(0.0597)	(0.0650)	(0.0674)	(0.0769)
Premium	0.0326***	0.0365***	0.0445***	0.0445***	0.0445***	0.0377***	0.0426***	0.0359***	0.0376***
	(0.0123)	(0.0129)	(0.0152)	(0.0152)	(0.0152)	(0.0131)	(0.0145)	(0.0126)	(0.0138)
ln(Duration)	0.0196**	0.0155*	0.0169*	0.0160*	0.0159*	0.0121	0.0161*	0.0162*	0.0219**
	(0.0084)	(0.0082)	(0.0088)	(0.0088)	(0.0088)	(0.0083)	(0.0086)	(0.0084)	(0.0091)
AVOL3 ($x10^{-3}$)			-0.0019*						
			(0.0010)						
AVOL5 ($x10^{-3}$)				-0.0041*					
				(0.0022)					
AVOL10 ($x10^{-3}$)					-0.0093*				
					(0.0051)				
InverPrice						0.0937*			0.0154
						(0.0535)			(0.0450)
DollarVol ($x10^{-3}$)							-0.0025**		-0.0002
							(0.0010)		(0.0012)
ZeroFreq								0.0524***	-0.0117
								(0.0171)	(0.0247)
N	527	527	461	463	463	527	472	527	472
Adjusted R^2	0.1070	0.0698	0.0641	0.0631	0.0623	0.0619	0.0662	0.0780	0.0936

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 5.7: The impact of short-sale constraints

This table reports the impact of short-sale constraints on the arbitrage excess return for the subsample of stock bids. All variables are described in Table 5.1. The figures in the parentheses are the heteroskedasticity-consistent standard errors of the coefficient estimates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-0.0403	-0.0535	-0.0146	-0.0491	-0.0511	-0.0705	-0.0301	-0.0982
	(0.1055)	(0.1064)	(0.1165)	(0.1423)	(0.1007)	(0.1021)	(0.1131)	(0.1211)
ln(TargetSize)	-0.0033				-0.0079			
	(0.0119)				(0.0068)			
VarProb	0.2039	0.1841	0.2672	0.1907	0.2103	0.1454	0.1667	0.1780
	(0.2068)	(0.1708)	(0.1886)	(0.1805)	(0.1987)	(0.1698)	(0.1924)	(0.1835)
Premium	0.0553	0.0560	0.0466	0.0560	0.0523	0.0539	0.0457	0.0526
	(0.0452)	(0.0455)	(0.0408)	(0.0459)	(0.0415)	(0.0424)	(0.0363)	(0.0414)
ln(Duration)	0.0147	0.0140	0.0116	0.0149	0.0136	0.0115	0.0025	0.0131
	(0.0212)	(0.0209)	(0.0231)	(0.0217)	(0.0218)	(0.0213)	(0.0237)	(0.0223)
InverPrice	0.0224***				0.0285***			
	(0.0068)				(0.0052)			
DollarVol ($x10^{-3}$)			-0.0016				-0.0043**	
			(0.0026)				(0.0019)	
ZeroFreq				0.0079				0.0376
				(0.0634)				(0.0463)
Inst	-0.0101	-0.0065	-0.0104	-0.0102				
	(0.0430)	(0.0437)	(0.0474)	(0.0430)				
AcqSize	-0.0060	-0.0058	-0.0125**	-0.0077				
	(0.0094)	(0.0051)	(0.0055)	(0.0074)				
ResInst					-0.0034	-0.0044	-0.0055	-0.0036
					(0.0044)	(0.0043)	(0.0049)	(0.0044)
N	123	123	102	123	123	123	102	123
Adjusted R^2	0.0197	0.0316	0.0285	0.0190	0.0289	0.0409	0.0193	0.0234

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

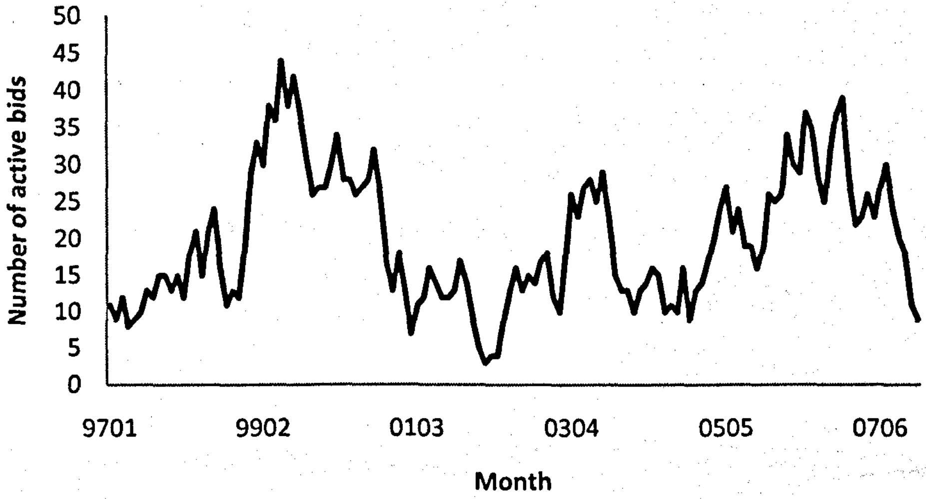

Figure 5.1: Number of active bids in each month from 1997 to 2007

This figure plots the number of active bids in the merger arbitrage portfolio in a particular month over the period 1997 – 2007

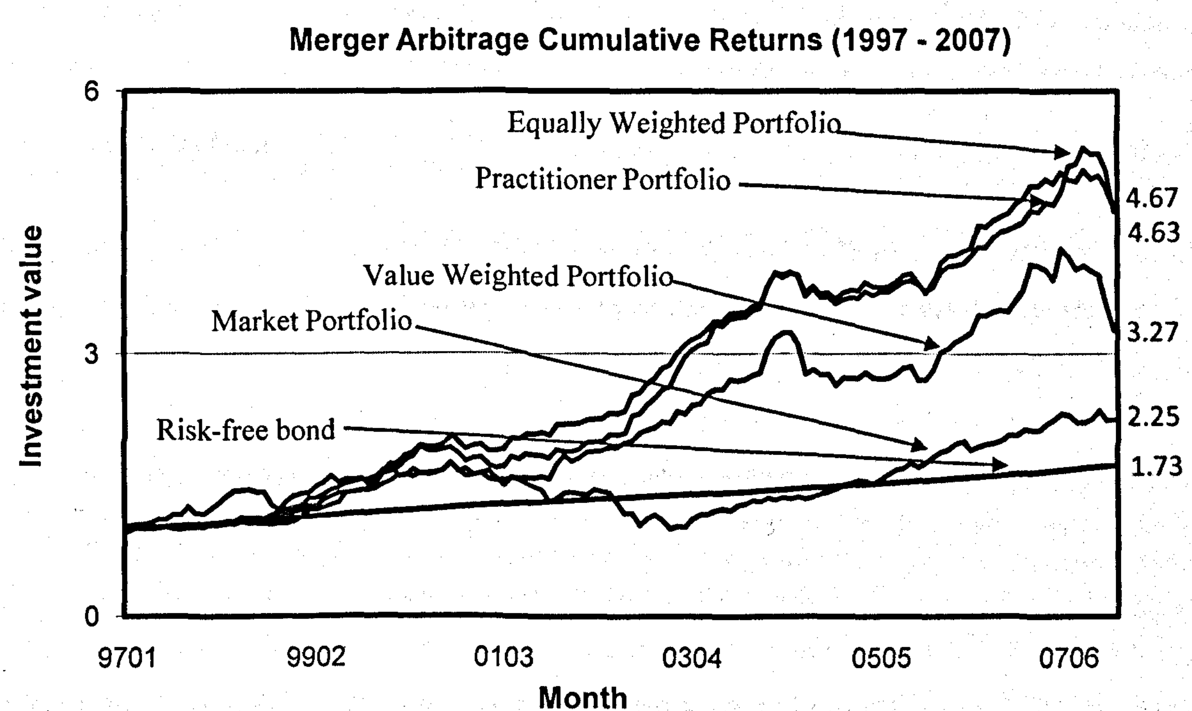

Figure 5.2: Growth of arbitrage investment from 1997 to 2007

This figure plots the value, over the time period of 01/01/1997 to 31/12/2007, of £1 investment at 01/01/1997 in three merger arbitrage portfolio return series, the market portfolio and the risk-free bond.

Chapter 6: ARBITRAGEURS' ROLE HYPOTHESIS

6.1 Introduction

The result of the empirical test of the risk-based hypothesis in Chapter 4 shows that the arbitrageurs can earn substantial return in excess of the benchmark for systematic risk or abnormal return. The empirical test of the limited arbitrage hypothesis in Chapter 5 indicates that the excess return to the strategy may stem from the additional risks and costs other than systematic risk that the real-world arbitrageurs have to face. In this chapter, we test the arbitrageurs' role hypothesis, which provide another plausible explanation for the source of the excess return to the strategy. As the discussion in Section 2.3.3 shows, there are three roles that arbitrageurs can play during the takeover process, that is, the naive investors, the passive investors and the active investors. Each role has different implication for the source of the excess return to the merger arbitrage strategy.

First, as naive investors, the arbitrageurs act like an average investor in the market and invest in a random portfolio of takeover bids. For naive arbitrageurs, the excess return represents the compensation for different types of risks and costs other than systematic risk or reflects the inefficiency in the pricing of merger stocks. The source of excess return to naive arbitrageurs is the content of the limited arbitrage hypothesis discussed in Chapter 5.

Second, as passive investors, through internal research or information acquisition the arbitrageurs possess superior knowlege about the bid outcome. Hence, they have the ability to select the best bids, investment in which can generate higher risk-adjusted return than the risk-adjusted return to the average investors in the market. The arbitrageurs is passive in the sense that they do not leverage their stakes in the target to influence the bid outcome. For passive arbitrageurs, the source of the excess return is the arbitrageurs' superior knowlege about the outcome of the takeover bid. Third, when arbitrageurs assume the active role, they do not just 'sit on' their stakes in the target stock but actively leverage the stakes to influence the bid outcome. The active arbitrageurs derive their excess return through their ability to alter the course of the takeove bid.

Although we expect the real-world arbitrageurs should do better than the naive investors as the arbitrageurs are often professional asset management firms, most empirical studies on merger arbitrage implicitly assume that the arbitrageurs are naive investors. The way these studies select takeover bids is based on the availability of the data only and henece assume away the arbitrageurs' 'stock picking' ability or ability to influence the bid outcome. We are aware of only two empirical studies that take a step further to test the passive role and the active role of the arbitrageurs[28]. First, Larcker and Lys (1987) report that ex post success rates of takeover bids, in which arbitrageurs invest, are signficantly higher than the probablity of success perceived by the average investors in the market. This finding is consistent with the passive role of the arbitrageurs. Second, Hsieh and Walkling (2005) document that the arbitrageurs' holding of target stocks after the bid announcement date is higher for those bids with more favourable outcome i.e. have higher bid premium, higher probability of bid success and can generate higher arbitrage return. At the same, bid premium and probability of success increase with the level of arbitrage holding. These findings are consistent with both the active role and passive role.

In this chapter, following the approach similar to Baker and Savasoglu (2002) and Hsieh and Walkling (2005) to identify arbitrageurs and calculate arbitrage holding, we attempt to provide empirical evidence about the passive role and the active role of the arbitrageurs in the UK context. In particular, we test whether arbitrage holding[29] can help explain the cross-sectional variation of arbitrage return beyond the explanatory power of other factors that can determine the outcome of takeover bid. Also, we test whether the level of arbitrageurs' holding of target stocks has positive impact on bid premium and the probability of bid success as predicted by Cornelli and Li's (2002) model. One of the premises of the model is that the arbitrageurs can hide their presence

[28] For a detailed discussion of these two studies, please see Section 2.3.3, Chapter 2.
[29] The procedure to identify arbitrageurs and obtain arbitrage holding is discussed in Section 6.4.2

when acquiring stakes in the target. The anonymity gives the arbitrageurs an edge in trading with other investors in the market enabling them to earn abnormal return. The strict UK disclosure rule during the takeover period makes the anonymity assumption rather tenuous. As argued later in section 6.2.2, since the disclosure rule during the takeover period is much stricter in the UK than in the US, where Hsieh and Walkling's (2005) study is conducted, we would expect different results about the UK arbitrageurs' ability to influence the bid outcome. This represents the advancement from the Hsieh and Walkling's (2005) study.

It is noted that we do not aim at differentiating between the active role and the passive role. As we already argued in Section 2.3.3, it is impossible to separate the active role from the passive role by examining the relationship between arbitrage holding and arbitrage return, bid premium and the probability of bid success. The main purpose of this chapter is to test the prediction based on Cornelli and Li's (2002) theoretical model about how the presence of arbitrageurs influences the bid outcome and the condition for the prediction to hold.

The chapter is organized as followings. Section 6.2 develops empirical hypotheses based on the theoretical framework discussed in Section 2.3.3. Section 6.3 discusses the methodology for the empirical tests. Section 6.4 describes the data and sample selection process Section 6.5 presents the empirical results. Section 6.6 summarizes the chapter.

6.2 Hypotheses development

6.2.1 The relationship between the arbitrage holding and arbitrage return

As the main purpose of the study is to perform empirical investigation into how the roles of arbitrageurs can explain the source of the merger arbitrage return, we will first derive the hypothesis that links arbitrage holding with arbitrage return.

The first hypothesis is predicated on the presumption that the arbitrageurs are better than the average investors in the market, which enables them to earn higher risk-adjusted return. The presumption is justified by the fact that the real-world arbitrageurs are often professional managers, who charge a hefty fee to manage capital for clients (Shleifer and Vishny, 1997). Thus, they have both the resources and the ability to be better informed about the outcome of the takeover bids. Further, as a professional investor, the arbitrageurs have sufficient capital to acquire large stake in the target stocks and hence have the ability to influence the bid outcome.

If the arbitrageurs are better than the average investors, it is expected that the arbitrageurs earn higher excess return than the average investors. In case they have superior knowledge about the bid outcome, they can choose the bids, investment in which yields better risk-adjusted return. When they have the ability to alter the course of the takeover, they will influence the bid in the way that enables them to earn higher return. Thus, if these conjectures are true, we expect a positive relationship between arbitrage holding and arbitrage return.

Cornelli and Li (2002) also suggest that the relationship between arbitrage holding and arbitrage return may be non-linear. When the arbitrageurs buy a large number of target stocks, i.e. the level of arbitrage holding is high, the ensuing buying pressure might push up the price of the target stock, thereby reducing the arbitrage return. Thus, arbitrage return may be positively related to arbitrage holding when the level of arbitrage holding is not too high. The relationship may turn negative when the level of arbitrage holding passes a certain threshold. Hence our first hypothesis is:

Hypothesis 6.1: *Arbitrage excess return is increasing with arbitrage holding when the level of arbitrage holding is below a certain threshold but is decreasing with arbitrage holding when the level of arbitrage holding is above that threshold.*

It is noted that we do not assert any causal link between arbitrage return and the presence of arbitrageurs. As will be discussed in greater detail in Section 6.3, arbitrage return may be endogenously related to arbitrage holding. When the arbitrageurs are informed about the potential bid outcome, they adjust their investment accordingly. However, the arbitrage investment can also affect the bid outcome variables, which also can influence arbitrage return.

6.2.2 The impact of UK takeover regulation

The second hypothesis tests the theoretical prediction in Cornelli and Li's (2002) model about the condition for the arbitrageurs to influence the bid outcome. As the discussion in Section 2.3.3 points out, the arbitrageurs have the ability to alter the course of the takeover process because they become the temporary large shareholders in the target firm after the bid announcement. As the large shareholders, their presence helps resolve the free-rider problem and hence increases the probability of bid success. Thus, the prerequisite for the arbitrageurs to affect the bid outcome is that they can acquire large stakes in the target firm. Because the arbitrageurs come to the takeover game not to influence the bid outcome but to make profits, the condition should be stated such that the arbitrageurs expect to earn positive abnormal return via their acquisition of large stakes in the target.

Cornelli and Li's (2002) argue that the condition can be fulfilled only if arbitrageurs can hide their presence. Since the arbitrageurs have the ability to influence the bid outcome, their presence, when being revealed, signals that the takeover bid is likely to succeed with favourable outcome. As a result, if the sellers of the target stock know that the arbitrageurs are in the game, they will raise their reservation price. Thus, if the arbitrageurs are forced to disclose their trading position too soon, they will have to buy the target stocks with a higher price, thereby reducing the arbitrage profits. In this scenario, the arbitrageurs' ability to influence the bid outcome give them little trading advantage. Consequently, they have no incentive to take a large position in the target stock and therefore are unable to influence the bid outcome. Early disclosure of the stake building by arbitrageurs reduces both the profitability of such stakes and their ability to increase the chance of a successful bid. Thus, the ability to conceal their presence is the crucial condition for arbitrageurs to influence the bid outcome.

According to Cornelli and Li (2002), arbitrageurs can hide their position via two channels. First, noise traders[30], as in the trading models propounded by Kyle (1985) and

[30] Black (1986) refers to noise traders as those who trade based on things that they think are information but actually are not. In other words, these traders trade on pseudo-information or noises.

Kyle and Vila (1991), may provide a camouflage for the arbitrage community. As reported by Hsieh and Walkling (2005), in those bids, where the abnormal trading volumes of the target shares are high, suggesting high noise trading, the empirical evidence about the arbitrageurs' ability to influence the bid outcome becomes more pronounced. The higher the noise trading is, the easier arbitrageurs are able to hide their trades. Second, each arbitrageur only acquires the target shares up to the threshold that triggers a disclosure obligation (e.g. in US, UK, it is 5%, 1% of the target shares respectively[31])

The disclosure rule is of great importance for the arbitrageurs to affect the bid outcome because noise traders can only provide camouflage for the arbitrageurs as long as they own less target shares than the disclosure threshold. Above the disclosure threshold, the arbitrageurs are required by the laws to disclose their trading position and hence no amount of noise trading can help them hide their identity in such case. Empirical testing of the impact of disclosure rules on the arbitrageurs' ability to influence the bid outcome is generally a thorny issue. As disclosure rules are set at country level, the test must involve cross-country studies with significant differences in the rules. As the evidence for the US market is already available, empirical tests of data from another country with different disclosure rules will provide insights into merger arbitrage.

In this study, we argue that the UK provides this alternative empirical context that neatly fits such profile. The UK disclosure rules are substantially different from those in the US. As will be articulated later, the UK disclosure rules during the bid period (or more commonly called 'offer period' under the City Takeover Code) are much stricter than their US counterparts. Thus, by empirically examining the arbitrageurs' ability to influence the bid outcome in the UK and comparing the result with the US study by Hsieh and Walkling (2005), we can see the impact of disclosure rules on the arbitrageurs' ability to affect the outcome of the takeover bid.

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[31] The maximum amount of target shares that trigger disclosure obligation varies among countries. In the US, the threshold is 5%; in the UK it is 1%. Please see Kenyon-Slade (2004) for more details.

The disclosure rules during the takeover period are the regulatory response to secretive stake building. The rationale behind the rules is to allow the current shareholders of a potential target firm to be alerted to any imminent takeover offer. If the bidder is not required to disclose its share ownership, it can secretly acquire a large stake at the current, possibly undervalued market price and then announce the offer. In this way the acquiror can reduce the acquisition cost and may be able to coerce the remaining shareholders to tender their shares at a lower price.[32]

In the US, Section 13(D) of the Securities Exchange Act and Rule 13D-1(a) of Regulation 13D provide that any person who, directly or indirectly, acquires "beneficial ownership" of 5% or more of any class of equity security that is subject to the provisions of Section 13(D) shall file a disclosure statement on Schedule 13D with the SEC within 10 business days after the acquisition. In the UK, under rule 8.3 of the UK City Code on takeovers, during an offer period a party has to disclose its all trading as long as having interest in 1% or more of the target shares and the disclosure has to be made *on the next business day* after the date on which the trading occurs.

It is quite clear that the UK the disclosure rules are much stricter on two accounts. First the disclosure threshold is considerably lower (1% in the UK versus 5% in the US). Second, the timetable for disclosure is relatively lax in the US. In the UK because the disclosure must be made on the next business day, there is little chance for arbitrageurs to accumulate more than 1% of target shares in secrecy. If they start buying too many shares in one day, their presence will be uncovered from a surge in trading volume. In the US, the arbitrageurs have 10 business days to accumulate more shares in excess of 5% threshold. As a result, it is considerably easier for US arbitrageurs to become a large shareholder of the target firm before having to reveal their identity. Mikkelson and Ruback (1985) find that the average size of the investment recorded in 479 13-D filings is 21.38 percent of the target outstanding shares, which is more than 4 times greater than the threshold for disclosure.

[32] Such secret stake building has been suggested as a solution to the free rider problem. See Sudarsanam (2003, ch18) and Titman and Grinblatt (2006, ch20)

The lax disclosure rule in the US may help explain the significant empirical support for the arbitrageurs' ability to influence the bid outcome reported by Hsieh and Walkling (2005). However if the impact of the disclosure rule is true, we should expect a much weaker, if any, impact of UK arbitrageurs on the bid outcome due to their difficulty in hiding their position. Hence our second hypothesis is:

Hypothesis 6.2: *In the UK market, arbitrage holding has little impact on the outcome and the terms of the bid. More specifically, arbitrage holding has little impact on bid premium and the probability of bid success.*

Cornelli and Li's (2002) theoretical model is predicated on the assumption that arbitrageurs can effectively hide their presence and predicts, as a consequence, a positive relationship between the presence of arbitrageurs and bid premium and the probability of bid success. The above argument indicates that due to the UK's far stricter disclosure rules it is very difficult for arbitrageurs to hide their position. Thus we would expect a different relationship between arbitrage holding and those bid-related variables. Contrary to the model prediction of a positive relationship, we expect no significant relationship.

6.3 Methodology

6.3.1 Empirical tests

Hypothesis 6.1 examines the relationship between arbitrage holding and arbitrage return. To test the hypothesis, the following equation needs to be estimated

$$ER_i^A = \alpha_0 + \alpha_1 holding_i + \alpha_2 holding_i^2 + \sum_{j=3,k} \alpha_j X_{ij} + \epsilon_i \qquad (33)$$

where ER_i^A is annualized arbitrage excess return, $holding_i$ is arbitrage holding measured as the percentage of the target's equity shares purchased by the arbitrage community. The procedure to identify arbitrageurs and calculate arbitrage holding is discussed in Section 6.4.2. X_{ij} is the set of control variables, ϵ_i is the error terms in the equation, and the subscript i denotes the takeover bid i in the sample. To calculate the annualized arbitrage excess return, we first compute the compounded excess return to the arbitrage investment in bid i over the duration of the bid using the following equation:

$$ER_{ci} = \prod_{t=1}^{K_i}(1 + ER_{it}) - 1 \tag{34}$$

where ER_{ci} is the compounded excess return to the arbitrage investment in bid i, K_i is the number of trading days from announcement date to the resolution date of bid i. For successful bids, the resolution date is the date on which the bid is declared completed or unconditional as reported in SDC. For failed bids, the resolution date is one day after the date on which the bid is withdrawn. ER_{it} is the daily excess return to the arbitrage investment in bid i on day t. The method to calculate ER_{it} is described in Section 5.2.1, Chapter 5.

Finally, the annualized excess return is obtained from the compounded excess return using the following equation:

$$ER_i^A = \frac{ER_{ci} \times 365}{N_i} \tag{35}$$

where N_i is the number of calendar days from the announcement date to the resolution date.

As will be discussed in the next section, the set of control variables in X_{ij} represent the factors that can influence the outcome of the bid as well as the market's assessment of the bid outcome. Information about X_{ij} is known to the public at the bid announcement date. Since arbitrage return depends on bid outcome, these publicly known factors also affect the arbitrage return. If the arbitrageurs are better than the average public, the bids, in which the arbitrageurs invest, would yield higher risk-adjusted return. As a result, after all the publicly known factors are taken into account, a positive relationship between arbitrage holding and arbitrage return should be observed. In equation (33), α_1 should be positive. The variable $holding_i^2$ in equation (33) is included to control for the possible non-linear relationship between arbitrage return and arbitrage holding. When arbitrage holding passes a certain threshold, the relationship between arbitrage holding and arbitrage return might turn negative. Thus, if the non-linear pattern exists, we would expect $\alpha_2 < 0$.

To test Hypothesis 6.2 about the arbitrageurs' ability to alter the course of the takeover process, we estimate the following equations:

$$Premium_i = \beta_0 + \beta_1 holding_i + \sum_{j=2,k} \beta_j X_{ji} + u_i \tag{36}$$

$$Prob(Success_i) = \gamma_0 + \gamma_1 holding_i + \sum_{j=2,k} \gamma_j X_{ji} + v_i \tag{37}$$

where $Premium_i$ is the bid premium. The measurement of bid premium is discussed in Section 5.2.2. To recap, bid premium is the sum of price run-up and mark-up. The price run-up is the cumulative abnormal return to the target shares for trading days (-40,-1) before the bid announcement date. Mark-up, is computed as $(FP - P_{-1})/P_{-1}$ where P_{-1} is the target stock price one day prior to the bid announcement date and FP is the final offer price. $Prob(Sucess_i)$ is the probability of bid success. X_{ji} is the set of control variables, and u_i and v_i are the error terms in these equations. According to Hypothesis 6.2, due to the strict UK disclosure rules, the UK arbitrageurs have little chance to exert influence on the bid outcome. In other words, when other variables that can affect the outcome of the bid are taken into account, arbitrage holding should have no impact on the probability of bid success and bid premium. Thus, we expect that β_1 and γ_1 are all equal to zero.

Estimation

Before discussing the methods to estimate the set of equations: (33), (36), and (37), we first examine whether or not these equations are sufficient in capturing the relations between arbitrage return, bid outcome variables, i.e. bid premium and probability of the bid success, and arbitrage holding. Arbitrage holding is placed on the right hand side of each equation as the primary explanatory variable. Thus, if we presume that these equations can model the true relationships between these variables, we impose an implicit assumption that arbitrage holding is exogenous variable, that is, it is determined outside these models. This assumption seems tenuous, nevertheless. As argued in Section 2.3.3, since the arbitrageurs are likely to be better informed about the bid outcome, their decision to enter the game and hold target shares, is influenced by arbitrage return and bid outcome variables. For instance, arbitrageurs might increase their purchase of target shares in those bids with higher expected returns, higher bid premium and higher probability of bid success. If this is true, these three equations are inadequate in modelling the relationship between arbitrage return, bid outcome variables and arbitrage holding. We need to add the following equation that shows the determinants of arbitrage holdings into the system:

$$holding_i = \varphi_0 + \varphi_1 ER_i^A + \varphi_2 Premium_i + \varphi_3 Prob(Success_i) + \sum_{j=3,k} \varphi_j X_{ji} + e_i \quad (38)$$

All variables in equation (38) are described in equation (33), (36) and (37) except for e_i, which is the error term of the equation.

The system of equations: (33) and (36)-(38) seems to be general enough to model the relationship between arbitrage holding and arbitrage return and bid outcome variables. Conditional on the true value of the parameters in equation (38), different estimation methods can be applied. There are two main scenarios:

Scenario 1

Arbitrage holding is not influenced by arbitrage return and bid outcome variables ($\varphi_i = 0$, for all $i = \overline{1,3}$). In this scenario, we can discard equation (38) from the system. The initial set of three equations from (33), (36) and (37) is sufficient to model the relationship among the variables of interest.

Assuming there is no measurement error or omitted variable, the assumption that arbitrage holding is exogenous variable is maintained. As a result, we can estimate each equation using a standard procedure. When the dependent variables are continuous, as in the case of equations (33) and (36), Ordinary Least Squares (OLS) method can be employed. When the dependent variable is binary, as in the case of equation (37), logistic regression can be applied.

Scenario 2

Arbitrage holding is determined by arbitrage return or at least one of the bid outcome variables ($\varphi_i \neq 0$, for at least one $i = \overline{1,3}$). To clearly illustrate this scenario, consider the simplest case where only one of the main independent variables in equation (38) is significant, say, bid premium. This means that $\varphi_2 \neq 0$, and $\varphi_1$and φ_3 are equal to 0. Because arbitrage holding is not influenced by arbitrage return and the probability of bid success, it is exogenous variable in equation (33) and (37). Hence, for these two equations, standard estimation procedures can be applied.

Turning to equation (36), the independent variable, arbitrage holding, is partially determined by the dependent variable, bid premium. In other words, arbitrage holding and bid premium are jointly determined. In such case, Wooldridge (2002) shows that arbitrage holding would correlate with the error term of the equation. Thus, it becomes an endogenous independent variable. In the presence of endogeneity, the OLS method will give biased and inconsistent estimates of equation (36). The traditional solution to the endogeneity problem is to find appropriate instrument variables (IV) for the endogenous variable and then use the IV estimators to get the consistent estimates of the coefficient. According to Larcker and Rusticus (2008), when the endogeneity problem arises from the fact that the independent variable is partially determined by the dependent variable, there are two general approaches to obtain the IV estimators. First, we can estimate equation (36) independently using the 2 Stage Least Squares (2SLS) regression. Second, we can estimate both equation (36) and (38) concurrently in a system of simultaneous equation using 3 Stage Least Squares (3SLS). While the system estimation method with 3SLS is more efficient than the single-equation estimation with 2SLS, the former implies more effort needed in finding appropriate instrument variables. As the 3SLS method uses the information from one equation in estimating the other equations in the system, in order to obtain consistent estimates for any equation it would require appropriate instrument variables for the endogenous variables in all equations in the system. The 2SLS method, by contrast, only requires the appropriate instrument variables for the endogenous variables in the equation of interest.

In this simplest case of the second scenario, to estimate equation (36) we would need to find instrument variables for both arbitrage holding and bid premium if 3SLS is employed, whereas in case 2SLS is employed, only instrument variables for arbitrage holding are needed. In a more general case where we expect that arbitrage holding is also determined by arbitrage return and bid outcome variables, to estimate equation (33), (36) and (37), we would need instrument variables for 4 variables – arbitrage holding, arbitrage return, bid premium, and probability of bid success – if 3SLS is chosen but only need instrument variables only for arbitrage holding if 2SLS is employed.

If finding appropriate instrument variables is an easy task, the straightforward estimation option should be 3SLS. However, it is actually a very daunting task (Maddala, 1986; Stock et al., 2002). As pointed out by Larcker and Rusticus (2007, 2008), in most practical applications, the instrument variables are less than ideal, which means that the IV estimators are often biased and inconsistent. Such bias and inconsistency are magnified through the 3SLS procedure. Thus, Larcker and Rusticus (2008) suggest that even when the researcher chooses to use 3SLS, he/she should also report the 2SLS result. The result from 3SLS is valid only if it is similar to the one from 2SLS.

Given the fact that we need to find appropriate instrument variables for fewer endogenous variables if 2SLS is employed compared to the circumstance under which 3SLS is employed (1 versus 4), 2SLS is clearly the better method in our case. Furthermore, the dependent variable in equation (37), i.e. the probability of bid success, is not observed and needs to be estimated by logistic regression. As logistic regression uses a maximum likelihood method rather than the least squares method to estimate the coefficients, it is impossible to simultaneously estimate equation (37) with equation (38) using 3SLS. As will be discussed in more detail in section 6.5.2, for this equation, a variation of 2SLS method can be applied to resolve the endogeneity problem. For all these reasons, in this paper, 2SLS will be the preferred method of dealing with the possible endogeneity problem.

In the first scenario, we assume that the endogeneity problem is not present and we can apply standard the approach, that is, the OLS and logistic regression, for estimation. In the second scenario, the endogeneity problem is assumed and we use the 2SLS procedure. To evaluate which of these approaches is appropriate, we need to perform statistical test to determine whether endogeneity is present. Larcker and Rusticus (2008) suggest that the IV estimators are always less efficient than OLS estimators in the absence of endogeneity. In that case, OLS may therefore be adequate.

The common test for endogeneity is the Hausman (1978) test. As shown by Larcker and Rusticus (2008), the validity of Hausman test is contingent on the appropriateness of the instrument variables. An appropriate instrument variable has to meet two requirements. First, it is not correlated with the error term of the equation. This requirement is equivalent to the statement that the instrument variable is exogenous. Second, it has non-zero correlation with the endogenous variable. The IV estimators obtained through 2SLS are consistent as long as both of these requirements are satisfied. Thus, Larcker and Rusticus (2008) suggest the first step in the empirical procedure to deal with the endogeneity problem is to show that the instrument variables are valid. We describe the tests for a valid instrument variable in more detail in section 6.5. In the next section, we discuss the set of control variables employed in the equations: (33), (36) and (37).

6.3.2 Control variables

The set of control variables include the factors that can influence the outcome of the takeover bid and the market's assessment of the bid outcome. These factors are discussed in the bid outcome model in Section 3.4, Chapter 3. In this section, we discuss the variable that represents the market's assessment of the bid outcome, that is, the arbitrage spread. We also include bid duration as the additional control variable to take into account the difference in durations among the takeover bids in the sample.

Arbitrage Spread (*Spread*)

The spread is defined as the percentage difference between the initial offer price and the target stock price one day after the bid announcement date. The spread reflects the prevailing market wisdom about the bid outcome around the time the bid is announced. Brown and Raymond (1986) and Samuelson and Rosenthal (1986) document that the movements of post-announcement target share price provide accurate forecast of the final outcome of the takeover bid. Jindra and Walkling (2004) perform a comprehensive study the information content of the arbitrage spread 2 days after the bid announcement date. The study reports that while controlling for other ex ante bid characteristics, the spread yields an excellent prediction about the realized terms and outcome of the bid. In particular, successful bids are associated with lower arbitrage spreads; the frequency the bid is revised upward is negatively related to the spread; and bid duration is positively related to the spread. In around 23% of the cases, the spreads become negative implying the market perception of an inadequate offer on the table or the expectation of an imminent upward revision by the original bidder or a higher offer from other bidders.

Bid Duration (*Duration*)

This is the only control variable that is unobservable at the bid announcement date. As the annualized arbitrage return is also a function of the bid duration, this variable accounts for the cross-sectional variation in arbitrage return stemming from the difference in bid durations.

The description of all variables used in this chapter is presented in Table 6.1. Many of variables are already described in Table 3.2, Chapter 3. For convenience, we still present in Table 6.1 those variables that have been described in Table 3.2.

[Insert Table 6.1, page 207 here]

6.4 Data and sample selection

6.4.1 Sample of takeover bids

In this chapter, we use the same sample of takeover bids as the sample employed in the testing of the limited arbitrage hypothesis in Chapter 5. The sample selection process is reported in Section 3.2.2, Chapter 3. The sample includes 653 UK takeover bids cover 11 year period from 1997 to 2007. The descriptive statistics for the sample are presented in Section 5.3.1, Chapter 5.

Sources to collect data about the variables used in this chapter are described in Section 3.2.1, Chapter 3. Next, we focus on the data source and the procedure to identify arbitrageurs and their holding.

6.4.2 Identification of arbitrageurs and their holding

As there is no database which enumerates the identity of merger arbitrageurs, we follow the empirical procedure similar to the one adopted by Baker and Savasoglu (2002) and Hsieh and Walkling (2005) to identify arbitrageurs and their holdings of target shares. Arbitrageurs are those who actively purchase the target' shares after the bid is announced. We only focus on the purchases of the target shares because the investment in both cash and stock bids involves a long position in the target stock. Thus, the arbitrage holding of target stocks reflects the level of the arbitrageurs' participation in the game. We rely on the trading disclosure filings to London Stock Exchange to record the purchases of arbitrageurs.

In the UK, under rule 8.3 of the City Code, any party must disclose all their trades in the shares of an entity involved in mergers if the party has interest in 1% or more of the entity's share. It should be emphasized that as long as a party has interest in 1% or more of the target shares, it has to disclose its all trading even if the trading involve as few as 1 share. The party has to make a filing on the *next working day* after the date on which the trading occurs. We collect all trading disclosure filings under rule 8.3 from Perfect Filings database. A sample of the filing under 8.3 of the City Code is presented in Appendix 6.1.

Because the filing has to be made the next day, each filing typically reports all the trades on a single day. If a party purchases the target share throughout the merger period, it may have to submit dozens of filings. Thus, in case dozens of parties decide to buy the target's shares, hundreds of filings will be submitted in a takeover bid. To get the number of target's shares that each party purchases in a bid, we need to manually pick the figures from each filing and aggregate them. This is an arduous process that took us more than 7 months to complete.

After collecting the holdings of target's shares by all parties in all takeover bids in the sample, we follow the procedure suggested by Baker and Savasoglu (2002) and Hsieh and Walkling (2005) to identify the arbitrageurs. In particular, we categorize those parties who purchase the target's shares after the bid announcement in at least 8 different bids as arbitrageurs. Since arbitrageurs enter the takeover game to make a short-term bet on the outcome of the bid, we discard the parties having long-term strategic interest with the bidder or the target firm. Hence, we exclude all parties that quote the reason for submitting the filings as being the bidder's or the target's associate.

After identifying arbitrageurs, we aggregate all purchases of each arbitrageur from the bid announcement date to bid resolution date to obtain the arbitrage holding for individual arbitrageurs. Next, we aggregate all individual arbitrageurs' holdings in a bid to get the total arbitrage position in a bid. We use this aggregate arbitrage holding as our measure of arbitrageurs' presence in a takeover bid. We scale the arbitrage holding by the number of target's shares outstanding at the bid announcement date. Thus, arbitrage holding measures the percentage of target shares purchased by the arbitrage community from the bid announcement date to the bid resolution date.

The way we collect data about arbitrage holding introduces a downward bias as we only record the purchase of those arbitrageurs who own 1% or more of the target's share during the takeover period. Those arbitrageurs who own less than 1% of the target's shares are excluded from the sample because of non-disclosure[33]. In other words, our sample includes the holdings of only arbitrageurs who cannot hide their arbitrage positions due to the UK strict disclosure rules. To the extent that we want to see the impact of the UK disclosure rules on the arbitrageurs' ability to influence the bid outcome, this downward bias should have little impact on the empirical validity of this study. If we find that the holding of the arbitrageurs, who are forced to reveal their presence, has no impact on takeover outcome, this piece of evidence would validate the prediction. On the other hand, a significant impact would clearly invalidate the prediction about takeover regulation.

6.4.3 Summary statistics

In this section, we present the descriptive statistics for arbitrage holding and some univariate tests to have some initial ideas about the relationship between arbitrage holding and bid-related variables. Table 6.2 reports the distribution of arbitrage holding and the number of arbitrageurs over the sample period.

[Insert Table 6.2, page 209 here]

As can be seen, there is a huge variation in the distribution of arbitrage holding and the number of arbitrageurs across the takeover bids in the sample and across the sample period. The mean and median of arbitrage holding is low for the year 1997-2003 (around 1.3% and 0% for mean and median respectively) and increase remarkably during the last 4 years of the sample period (around 4.5% and 1% for mean and median respectively). The fact that mean holding is much greater than the median holding indicates that the distribution of this variable is skewed toward some bids with high level of arbitrage holding. While in around 25% of the takeover bids, there is no

[33] To this extent our measure may understate the true arbitrage position

presence of the arbitrageurs, the maximum of arbitrage holding is up to nearly 50% of target's shares.

Table 6.3 presents the descriptive statistics for all variables used in the empirical tests of this chapter. We divide the samples into 2 subsamples. The first subsample includes observations with arbitrage holding greater than the median holding (the large holding subsample) and the second subsample contains the remaining observations (the small holding subsample). Descriptive statistics for all variables in these two subsamples as well as the result of the tests for the difference in mean and median between these subsamples are reported. These simple univariate tests provide us with some insight about the relationship between arbitrage holding and bid-related variables.

[Insert Table 6.3, page 210 here]

First, we look at the relationship between arbitrage holding and arbitrage excess return, bid premium and success rates. These relationships are the focus of the two hypotheses proposed in this chapter (Section 6.2). The result in Table 6.3 shows that arbitrage return is negatively related to arbitrage holding. Both mean and median of arbitrage excess returns are lower for the large holding group than for the small holding group, and the difference is statistically significant at 10% level. This result is consistent with non-linear relationship between arbitrage return and arbitrage holding. When arbitrage holding passes a certain threshold, the relationship becomes negative. In this univariate analysis, we do not know whether the relationship is positive when arbitrage holding is below the threshold.

The success rates of the bids in the large holding group are indistinguishable from the success rates of the bids in the small holding group. This finding shows that the presence of arbitrageurs has little impact on the outcome of the takeover bid. The result is consistent with Hypothesis 6.2 about the impact of the UK regulation on the arbitrageurs' ability to affect the bid outcome. Due to the stringent UK disclosure rules, it is expected that the level of arbitrage holding can hardly affect the outcome of the bid.

Interestingly, bid premium seems to be negatively related to arbitrage holding. The average premium is lower when arbitrage holding is larger than the median holding and the relationship is statistically significant at 5% level. This result runs counter to the prediction of Cornelli and Li's (2002) model about the relationship between bid premium and arbitrage holding. The result again shows the impact of the takeover regulation on the relationship between arbitrage holding and bid-related variables. We will explore the reason why the relationship between arbitrage holding and bid premium turns negative in more detail in the next section.

Among the remaining variables, arbitrage holding appears to be negatively related to both managerial ownership and large shareholders' ownership of the target firm. The level of managerial ownership and large shareholders' ownership is lower for the large holding group than for the small holding group and the difference is statistically significant at 1% level. As the managers are the insider and in the best position to be informed about the potential outcome of the takeover bid, they would never sell their shares if the probability of bid success is high. In such case, they can enjoy the full premium rather than giving up the arbitrage spread to the arbitrageurs. Furthermore, trading by insiders often trigger disclosure obligation. Thus, the arbitrageurs cannot acquire a lot of target shares if the level of managerial ownership is high. This explains the negative relationship between arbitrage holding and managerial ownership. The negative relationship between arbitrage holding and large shareholders' ownership is, to some extent, consistent with the Cornelli and Li's (2002) model. As the discussion in Section 2.3.3 shows, the arbitrageurs influence the bid outcome by playing the role of the large shareholders. Thus, if the pre-bid ownership structure of the target already contains high level of ownership by large shareholders, the arbitrageurs have less room to influence the bid. As a result, the arbitrageurs decrease their position when the target already has high level of large shareholders' ownership.

Arbitrage holding is higher for bids with multiple bidders. The multi-bidder situation is often associated with higher offer by the original bidder or the rival bidder, thus the expected return is greater. The profit-seeking arbitrageurs increase their holding to earn higher returns. Arbitrage holding is also higher for those bids that have a termination fee clause, for stock bids and bids conducted via scheme of arrangement. There appears to be no relationship between arbitrage holding and whether the bid is hostile or whether the bidder and the target are related i.e share the same 3 digit SIC code.

There is a negative association between arbitrage holding and arbitrage spread one day after the bid is announced. The arbitrageurs seem to follow the initial market assessment of the bid outcome. The arbitrageurs increase their holding when the spread is narrow indicating the market perception of a more likely successful bid or an imminent emergence of a rival bidder. Also, they decrease their holding when the market perceive low probability of bid success (a wide spread).

The level of arbitrage holding appears to be positively related to the size of the target firm. The percentage of the bids, whose target firms' total asset is greater than £70 million, is significantly greater for the large holding group than for the small holding group. The mean of the target size is also greater for the large holding group, though the relation is in opposite direction for median.

Finally, arbitrage holding is decreasing with toehold and the percentage of target's share irrevocably committed. It is quite obvious that the bidder would never sell their stakes in the target. The target shareholders, from whom the bidder obtain the irrevocable undertaking, also commit to only sell their stakes in the target to the bidder. As a result, the higher the level of toehold and the percentage of target's share are, the less target shares are available to be acquired by the arbitrageurs. This explains the negative relationship between arbitrage holding and toehold and the percentage of target's share irrevocably committed.

6.5 Empirical result

6.5.1 Arbitrage return and arbitrage holding

In this section, we test Hypothesis 6.1 regarding the relationship between arbitrage return and arbitrage holding by estimating equation (33). As the argument in Section 6.3.1 shows, arbitrage holding and arbitrage return may be jointly determined; in other words, arbitrage holding might be the endogenous variable in the equation. The first step of the empirical analysis is to find the appropriate instrument variables for the suspected endogenous variables. Since we use 2SLS to obtain the IV estimators, we only need to find instrument variables for arbitrage holding. Following Hsieh and Walkling (2005), we use $\ln(1 + Narb_i)$ as the instrument variable for arbitrage holding, where $Narb_i$ is the number of arbitrageurs in bid i and ln is the natural logarithm.

A valid instrument variable must meet two requirements: (1) it has zero correlation with the error term of the equation; and (2) it has non-zero correlation with arbitrage holding. When both these requirements are satisfied, the IV estimators are consistent (Wooldridge, 2003). The first requirement warrants that the instrument variable must be exogenous. This requirement nevertheless cannot be tested because the error term of the structural equation is unobservable. According to Murray (2006), researchers can never be certain that the instrument variable is exogenous. He also suggests that since the requirement cannot be subject to empirical scrutiny, reasoning should be applied to chase away as much doubt as possible. In this study, we argue that the instrument variable for arbitrage holding, i.e. the number of arbitrageurs, should have little correlation with the error term of equation (33). Since both the number of arbitrageurs and arbitrage holding can serve as valid proxy for the presence of arbitrageurs, the number of arbitrageurs should affect arbitrage return in a similar way as arbitrage holding. As a result, the error term of equation (33), the part of arbitrage return in which the impact of arbitrage holding is purged away, should have little correlation with the number of arbitrageurs. Thus, even though we are still not sure whether the number of arbitrageurs is completely exogenous, our reasoning shows that this is likely to be the case.

As for the second requirement, it can be directly tested with the data. Larcker and Rusticus (2008) argue that the evidence of non-zero correlation between the instrument variable and the endogenous variable is generally too weak for the 2SLS IV estimators to be superior to the OLS estimators in the presence of endogeneity problem. As we cannot be sure whether the instrument variable is truly exogenous, the second requirement should be modified to incorporate that reality. In their simulation analysis, Larcker and Rusticus (2008) report that when the instrument variable is weakly correlated with the endogenous variable, even though the correlation is different from zero, only a small correlation between the instrument variable and the model's error term will cause the 2SLS IV estimator to be more biased than the OLS one and make hypothesis testing under 2SLS become invalid. The authors suggest that requirement (2) should be modified such that the instrument variable should be highly correlated with the endogenous variable. Stated differently, we should find a strong instrument. When the instrument variable is strong, the 2SLS estimator is still preferred to OLS even if the instrument is semi-endogenous, i.e. has some mild correlation with the error term of the model.

Following such logic, our next step is to perform statistical tests to ensure that the number of arbitrageurs $\ln(1+Narb_i)$ is a strong instrument variable. We will use the result obtained from the first-stage regression in the 2SLS procedure to assess the strength of the instrument variable. The standard set-up for the first stage regression is to use the endogenous variable, in this case $holding_i$, as the dependent variable and the instrument variable $\ln(1+Narb_i)$ and the control variables as the independent variables.

The minimum requirement for $\ln(1+Narb_i)$ to be valid instrument is that the coefficient estimate of the variable is different from 0 in the first-stage regression (Wooldridge, 2003). The result in Panel A of Table 6.4 clearly shows that $\ln(1+Narb_i)$ passes this requirement. The variable is statistically significant at 1% level.

[Insert Table 6.4, page 211 here]

Although the test shows that $\ln(1+Narb_i)$ is a valid instrument variable, it does not warrant that the variable is a strong instrument. Stock and Yogo (2005) and Stock, et al (2002) develop a formal quantitative benchmark to assess the strength of the instrument variable based on the result of first stage regression. The benchmark set the minimum value for the size of the F-statistic on the instrument variable in the first-stage regression. In this case when we have one instrument, the F-statistic should be at least 8.96 so that the finite sample bias from 2SLS is smaller than the bias from OLS and the statistical inferences under 2SLS are valid. When F-statistic falls below the benchmark, the instrument variable is considered weak.

The F-statistic of 230.91 for $\ln(1 + Narb_i)$ in the first-stage regression is much higher than the benchmark value. This clearly shows that $\ln(1 + Narb_i)$ appears to be a strong instrument variable. Another way to look at the strength of the instrument variables and evaluate whether 2SLS is preferred to OLS in the presence of endogeneity is to calculate the partial R^2 between arbitrage holding and $\ln(1 + Narb_i)$ in this first stage regression. The partial R^2 is 41.99%. According to Larcker and Rusticus (2008), the size of the partial R^2 means that 2SLS is preferable to OLS in the presence of endogeneity problem unless the correlation between $\ln(1 + Narb_i)$ and the error term of the equation is more than 0.680 (the square root of 41.99%). This means that OLS is only a better choice when the endogeneity problem is present if the instrument variable $\ln(1 + Narb_i)$ is highly correlated with the error term. As we already argued earlier, given that arbitrage holding and the number of arbitrageurs are both the proxies for the arbitrageurs' presence in the takeover contest, there should be little correlation between the $\ln(1 + Narb_i)$ and the model's error term. Thus, in the presence of endogeneity, 2SLS seems to provide more reliable estimates.

In the first stage regression, the underlying assumption is that the endogenous variable $holding_i$ can be projected linearly on to the set of the exogenous variables. However, as argued by Wooldridge (2002), the assumption is only justified as long as the relation between the dependent variable and the endogenous regressor is linear. In case the relation is non-linear, it is impossible to derive the reduced form equation, in which the endogenous regressor is a linear function of the exogenous variables. Thus, if arbitrage returns are related to arbitrage holding in a non-linear way as stated in Hypothesis 6.1 (the coefficient of $holding_i^2$ in equation (33) is different from 0), the first-stage regression with the standard set-up is invalid.

Wooldridge (2002) suggests a simple solution to the non-linearity issue. We can consider the non-linear part of the endogenous variable ($holding_i^2$) as an additional endogenous variable. If $\ln(1 + Narb_i)$ is a good instrument for $holding_i$, then the square of the fitted value of $holding_i$ obtained from the first-stage regression described above ($fittedholding_i^2$) can serve as the optimal instrument for the $holding_i^2$. By doing so, the endogenous variable can be projected in a non-linear way onto the set of exogenous variables (Wooldridge, 2002). A set of statistical tests in Panel B of Table 6.4 shows that $fittedholding_i^2$ is also a strong instrument for $holding_i^2$.

To this stage we obtain the first step in dealing with the potential endogeneity problem by finding the appropriate instrument variable for the suspected endogenous variable. The next step is to perform the Hausman test on whether the suspected variables are truly endogenous. Larcker and Rusticus (2008) suggest that the validity of the test hinges on the appropriateness of the instrument variables. This explains our lengthy argument in selecting the instrument for the suspected variable. The result of the Hausman test is shown in Panel B of Table 6.4.

The Hausman test indicates that endogeneity may not be a big problem in estimating equation (33). The null hypothesis that there is no endogeneity cannot be rejected even at 10% significance level. As argued in Section 6.3.1, in the absence of endogeneity problem, OLS is the preferred estimation method. The estimation of equation (33) using both 2SLS and OLS method is reported in Panel A of Table 6.4.

The results under both the OLS and 2SLS show a similar pattern. The coefficient estimate of $holding_i$ is positive and of $holding_i^2$ is negative. This result is consistent with the fact that arbitrage excess return is related to arbitrage holding in a non-linear way as stated in Hypothesis 6.1. Below a certain level of arbitrage holding, arbitrage excess return increases with arbitrage holding, but the relationship turn negative when arbitrage holding passes that threshold.

Under the 2SLS specification, both coefficients are not statistically different from 0. As for the OLS result, $holding_i$ is significant at 10% level and $holding_i^2$ is significant at 5%. The fact that the coefficient estimates of $holding_i$ and $holding_i^2$ are insignificant when 2SLS is used but become significant when OLS is used demonstrates that OLS estimators are more efficient than 2SLS estimators i.e. have smaller standard errors. As the Hausman test does not detect any serious endogeneity problem, we rely on the OLS result. As statistical significance is obtained with the OLS result, the finding provides empirical support for Hypothesis 6.1.

Some of the control variables are significant and provide interesting insights into the determinants of merger arbitrage return. Arbitrage excess return is significantly higher in hostile bids. The result of estimating the bid outcome model in Section 3.4.2, Chapter 3 indicates that the target management's hostile attitude toward the bid is one of the biggest obstacles to bid success. Thus, the deal completion risk is much higher for the investment in those hostile bids. The higher excess return associated with hostile bid represent the compensation for the higher risk the arbitrageurs have to face. This result is consistent with the result in Chapter 5 showing that idiosyncratic risk, the major part of deal completion risk, has significant impact on arbitrage return. By the same token, arbitrage excess returns are also significantly higher for those bids with wider spread. The spread reflects the market's perception about the outcome of the bid. A wide spread implies that the market perceives a lower chance that the bid will complete and hence pose greater risk for the arbitrageurs.

The arbitrage excess return increases when more than one bidder compete to acquire the target. For stock bids, as the multi-bidder situation increases the risk for arbitrageurs, a higher return is required to make up for the risk. For cash bids, the multi-bidder situation is like a boon to arbitrageurs, the risk is reduced but the potential return is greater because the bid is more likely to be revised upward[34].

Finally, target size is significantly related to arbitrage returns. In particular, arbitrage return is lower in bids with large targets. This evidence is consistent with the fact that the marginal investors in the arbitrage game require compensation for bearing transaction costs. As the shares of large companies are usually more liquid than those of small firms, the transaction costs in trading large firm stock are usually smaller. This finding is consistent with the result in Chapter 5 that transaction costs are one of the important determinants of the arbitrage excess return.

[34] Please see Section 3.4 for a detailed discussion of why the arbitrageurs view the multi-bidder situation differently for stock bids and cash bids.

To sum up, we find supporting evidence for Hypothesis 6.1. The arbitrage holding has incremental power in explaining the cross-sectional variation of the excess return to the merger arbitrage strategy after a host of factors that can determine the bid outcome as well as the market's assessment of the bid outcome is controlled for. The finding precludes the possibility that arbitrageurs are just naive investors who hold a random portfolio of merger stocks. The relationship between arbitrage excess return and arbitrage holding is non-linear. Arbitrage return increases with arbitrage holding when arbitrage holding is below a certain threshold but decreases with arbitrage holding when arbitrage holding passes the threshold.

6.5.2 Bid outcome variables and arbitrage holding

Under Hypothesis 6.2, due to the UK's strict disclosure rules during takeover period, the arbitrageurs in the UK should hardly be able to influence the outcome of the bid. Thus, we expect that arbitrage holding has little impact on bid premium and the probability of bid success.

A. Bid premium

In order to examine the impact of arbitrage holding on bid premium, we estimate equation (36). As arbitrage holding might be endogenously related to bid premium, we repeat the procedure conducted in the previous section. The first step is to find an appropriate instrument variable for arbitrage holding. This step is fortunately completed as we already demonstrated extensively in the previous section that $\ln(1 + Narb_i)$ is a good instrument variable for arbitrage holding. The large F-statistic of the first-stage regression (more than 200) reported in Panel B of Table 6.5 confirms the strength of this instrument variable.

[Insert Table 6.5, page 214 here]

Following the argument from Larcker and Rusticus (2008), when a strong instrument variable is available, we can proceed to the Hausman test for the presence of endogeneity problem. The test statistic reported in Panel B of Table 6.5 is 0.78 indicating that the null hypothesis that arbitrage holding is exogenous variable cannot be rejected; hence endogeneity does not appear to be a serious problem. When the regressor is exogenous, OLS is the preferred method to estimation equation (36). The estimation result using both OLS and 2SLS are reported in Panel A of Table 6.5.

The result shows a statistically negative relationship between bid premium and arbitrage holding under both OLS and 2SLS method. With OLS, the relation is highly significant at 1% level; with 2SLS, it is significant only at 5% level. The OLS result seems to show stronger relationship because OLS estimator is generally more efficient than 2SLS estimator. The negative relationship between bid premium and arbitrage holding is consistent with the result in the univariate analysis in Section 6.4.3.

The result is in stark contrast with the prediction of Cornelli and Li's (2002) model, upon which the theoretical argument for the interaction between arbitrage holding and bid outcome variables is grounded. Their model predicts that as the bidder likes to attract more arbitrageurs into the game to solve the free-rider problem, it would offer a high offer ex ante or revise the offer upward. Thus, according to the model, there should be a positive relationship between arbitrage holding and bid premium. To reconcile the contradictory empirical results, we need to look at the basic premise of the model. The model assumes that arbitrageurs can hide their identity in the takeover game. Because there is inherent uncertainty regarding whether the arbitrageurs will come into the game to solve the free-rider problem, the bidder needs to make high pre-emptive bid or revise the bid upward in order to attract more arbitrageurs so that the bid can succeed and it can make a positive profit.

The UK's strict disclosure rule makes the assumption that arbitrageurs are anonymous rather tenuous. As argued in Section 6.2.2, compared to the US, where the positive relationship between arbitrage holding and bid premium is reported (Hsieh and Walkling, 2005), the UK disclosure rules are much more stringent. Thus, it is quite hard for the arbitrageurs in the UK to trade in target stocks without revealing their identity. In case the arbitrageurs are involved in the game and the bidder knows about that, it has no incentive to offer high bid to attract more arbitrageurs into the game. Even worse, when it knows that all those short-term arbitrageurs are likely to be involved in the game, it might even lower its offer price because if it walks away the arbitrageurs will burn their fingers. In this case, the bidder, instead of increasing the offer price to attract the arbitrageurs, may actually decrease the offer price if it is aware of the presence of arbitrageurs in the game. This may help explain the observed negative relationship.

The direct corollary of this argument is that the premia in those bids where the bidder is more likely to know about the presence of arbitrageurs before the bid announcement date will be lower than the premia in other bids. To test this corollary, we take a closer look at the definition of the term 'offer period', during which the strict disclosure threshold of 1% under Rule 8.3 of the City Code is applied. As reviewed by Kenyon-Slade (2004, p608), the offer period is defined as the period from the time when the announcement is made of a proposed or possible offer (with or without terms) until the date when the offer becomes or is declared unconditional as to acceptances or lapses. Based on this definition, the offer period starts before the announcement of the terms of the offer. The announcement date we use in this study is the date on which all terms of the offer are publicly disclosed not just the announcement of a possible offer. Thus, the arbitrageurs are bound by the disclosure obligation under Rule 8.3 of the City Code even before the announcement date.

If the arbitrageurs trade before the terms of the bid are publicly announced and are obliged to disclose their trades under rule 8.3 of the City Code, the bidder would know about the presence of arbitrageurs well in advance. Thus, if our conjecture about the impact of the UK strict disclosure on the relationship between bid premium and arbitrage holding is correct, the premium will be lower for those bids, in which the bidder knows about the arbitrageurs' presence before the bidder has to announce the terms of the offer.

The possibility that arbitrageurs acquire target stock before the bid announcement is also reported in previous studies. Larcker and Lys (1987) find that in 3 out of 111 bids, the arbitrageurs buy target share before the terms of the bid are announced. In a survey of 21 arbitrageurs, Moore et al (2006) find that 43% of these arbitrageurs admit that they, to some extent, also invest in unannounced transactions. The way that Hsieh and Walkling (2005) and Baker and Savasoglu (2002) identify arbitrageurs based on the change in holding from the quarter before the bid announcement date to the quarter after the bid announcement date also does not preclude the possibility that arbitrageurs acquire target shares before the offer terms are disclosed.

In our sample, there are 187 bids, in which the arbitrageurs need to reveal their identity before the bidder announces the offer terms. As nearly 30% of the sample bid, the bidder knows pretty well that the short-term arbitrageurs are in the game before it needs to announce the offer price, he may decide to lower the price. This helps explain the negative relationship between bid premium and the presence of arbitrageurs.

To further investigate this relationship, we compare the bid premium of those 187 bids with the rest of the sample. On average the bid premia of those bids are 6% lower than those of the other bids and the difference is statistically significant at 5% level. To test whether such difference are still robust when other factors that affect bid premia are controlled for, we add a dummy variable $DiscloseBefore$, which is equal to 1 if the arbitrageurs have to disclose their trading before the official bid announcement and equal to 0 otherwise, to the model. If the conjecture about the impact of the disclosure rules on the relationship between bid premium and arbitrage holding is correct, the coefficient estimate of the new dummy variable should be negative. The result in Panel A of Table 6.5 shows that this is really the case. The coefficient estimate of variable $DiscloseBefore$ is negative and marginally significant at 5% level. Thus, the impact is robust in multivariate context.

To provide further insight into this issue, we re-estimate equation (36) in two subsamples. The first one includes 187 bids in which the arbitrageurs have to reveal their position before the bid announcement; and the second one include the rest of the sample. As shown in Panel A of Table 6.5 , in the first subsample, arbitrage holding is negatively related to bid premium and the relationship is statistically significant at 5% level, while in the second subsample the relationship is not significant. This result confirms the conjecture about the impact of the disclosure rules on the relationship between bid premium and arbitrage holding.

The significance and sign of the impact of some of the control variables are also of interest. Whether the bid has multiple bidders appears to be one of the most important determinants of bid premium. The premia for bids with more than one bidder are approximately 20% higher than those with single bidder and the difference is significant at 1% level. This result is consistent with the large body of empirical evidence about the impact of competition among rival bidders on bid premium (Eckbo, 2009). For example, Eckbo and Langohr (1989) document that the bid premium increases substantially after the introduction of the mandatory disclosure rule and the requirement that the offer must be open for minimum 4 weeks in the French context. The reason is that such regulation makes the bid more transparent and open for longer period, thereby attracting more rival bidders into the game. Schwert (1996) also document similar result in the US context.

As the discussion in Section 3.4.1 indicates, while toehold is expected to have positive relation with bid premium, the result turns out to be negative in our sample. While the result is inconsistent with the argument that bidder can offer high premium if he has acquired large toehold in the target firm because such premium needs only be paid for the remaining shares. This can be called the toehold-related-overbidding hypothesis (Singh, 1998). However, as argued by Eckbo (2009), toehold also deters the arrival of new bidders as they may expect that it is difficult for them to win the contest. Because of such entry deterrence effect, toehold lowers bid premium. The evidence in this paper is consistent with this entry deterrence argument. Betton and Eckbo (2000) and Betton, et al. (2008) also report similar result. Since the number of shares irrevocably committed is expected to have similar impact as toehold, this explains why this variable is negatively related to bid premium. This also supports the entry deterrence argument.

Finally, bid premium is significantly higher in a cash offer than in a stock offer. This result is consistent with the information theory about the choice of payment method and the result reported by Betton, et al. (2008). Under the theory, a bidder chooses a stock offer in case it is uncertain about the true value of the target. In this case, he can underpay the target because any value enhancement later can be shared by both parties. However, a cash offer that undervalues the target will be rejected as the target shareholders have no involvement in the post-takeover firm.

In summary, the result for those control variables appears to be consistent with the extant literature. Arbitrage holding appears to be negatively related to bid premium. The negative relationship stems from the strict UK disclosure rule applied during the offer period.

B. Probability of bid success

In this section, we examine the impact of arbitrage holding on the probability that the bid will consummate by estimating equation (37). Similar to the previous sections, our first concern is the endogeneity problem and the first step to deal with this problem is to find an appropriate instrument variable for arbitrage holding, the suspected endogenous variable. The discussion in the previous sections indicates that $\ln(1 + Narb_i)$ is a strong instrument for arbitrage holding. As reported in Panel B of Table 6.6, the size of the F-statistics of $\ln(1 + Narb_i)$ (214.31) in the first stage regression under 2SLS is much larger than the critical value (8.96) confirms the strength of this intrument variable.

[Insert Table 6.5, page 214 here]

As long as the strong intrument variable is identified, we can perform the Hausman test on the presence of the endogeneity problem. The result of the test is reported in Panel B of Table 6.6. With the test statistic of only 1.65, the null hypothesis that arbitrage holding is exogenous variable cannot be rejected even at 10% significance level.

Since the endogeneity problem does not appear be serious, we can estimate equation (37) using logistic regression. This logistic regression is similar to the one employed in Section 3.4 to estimate the bid outcome model. To recap, the dependent variable of the logistic regression is the outcome indicator variable which is equal to 1 if the bid is successful and 0 otherwise. From the arbitrageurs' perspective, a cash bid is successful when the target is acquired, and a stock bid is successful when the target is acquired by the bidder whose stocks are shorted by the arbitrageurs. The independent variables include arbitrage holding and the set of control variables discussed in Section 6.3.2.

Alongside with logistic regression we also employ the least square estimation methods as shown in the previous sections. In particular, we perform the 2SLS estimation using $\ln(1 + Narb_i)$ as the instrument variable for arbitrage holding. We also report the OLS result for comparison. As the depenent variable in equation (37) is the probabilty of bid success, the major shortcoming of the least square method is that fitted value of the dependent varilabe may go beyond the [0,1] inveval. Consequently, the least square methods do not accurately model the probability of bid success. Despite this shortcoming with the least square method, Wooldridge (2003) suggests that the coefficient estimates under the least square methods are still consistent and can be valid for inference. According to the author, in applied work, it is acceptable to present the least square analysis of a linear probability model. When comparing the least square result with the one from the logistic regression result, we can see that they are very similar. The result using both the logistic regression and the least square methods is reported in Panel A of Table 6.6.

The results under the OLS, 2SLS and the logistic regression are similar. The coefficient esitmates of the variable $holding$ are negative and statistically insignificant in all estimation methods. The finding indicates that arbitrage holding has no impact on the the probability of bid success. In other words, the arbitrageurs have little ability to influence the outcome of the bid. This finding is consistent with Hypothesis 6.2 and indicates that the UK strict disclosure rule during the offer period has substantial impact on the interaction between the arbitrageurs' stakes in the target firm and the outcome of the takeover bid.

The characteristics of the control variables are gennerally consistent with the extant literature. The behaviours of all these variables are discussed in Section 3.4.2, Chapter 3 about the result of the bid outcome model.

In summary, our finding on the relationship between arbitrage holding and the probability of bid success provides support for Hypothesis 6.2. Due to the UK strict disclosure rule, there is little chance for the arbitrageurs to exert influence on the outcome of the bid to their advantage.

6.6 Chapter summary

Utilizing a manually collected dataset to identify arbitrageurs and their holding of the target stocks, this chapter performs empirical tests of the arbitrageurs' role hypothesis. In particular, we examine the roles that arbitrageurs play in the takeover process and the impact of these roles on the arbitrage excess return. Previous studies in the US market show that the arbitrageurs are superior in selecting the takeover bids for their portfolio, the investment in which would yield higher risk-adjusted return. We find similar evidence in this chapter. The arbitrageurs' holding of the target stocks is positively related to arbitrage excess return when arbitrage holding is below a certain threshold and is negatively related to arbitrage excess return when arbitrage holding surpasses that threshold. The relationship between arbitrage holding and arbitrage excess return holds when a host of factors that can determine the bid outcome and the market's assessment of the bid outcome are controlled for. This indicates that arbitrageurs are better than the average investors in the market in picking the best bids for the arbitrage portfolios.

In addition to the 'stock picking' ability, the extant US evidence also document that arbitrageurs have the ability to exert influence on the outcome and terms of the takeover bid. Hsieh and Walkling (2005) report that arbitrage holding is positively associated with bid premium and the probability of bid success. The finding is consistent with the theoretical prediction propounded by Cornelli and Li (2002). The theoretical model is, however, predicated on the assumptions that arbitrageurs have the ability to hide their identity during their trading with other investors. We argue that due to the stringent disclosure rules during the takeover period under the UK Takeover Code, this assumption is less likely to hold in the UK context. Thus, if the assumption is of great importance, our result regarding the relationship between arbitrage holding and bid premium and the probability of bid success is expected to be different from the result of the US study by Hsieh and Walkling (2005). We find that this is indeed the case.

In contrast to Hsieh and Walkling's (2005) finding, we report a significant negative relationship between the arbitrage holding and bid premium. The fact that the strict UK disclosure laws force the arbitrageurs to reveal their trading position too soon contributes to this relationship. If the bidder knows that the short-term arbitrageurs are already in the game, it would have no incentive to raise the offer price ex ante or revise the bid upward ex post to attract more arbitrageurs into the contest as predicted by Cornelli and Li (2002). In fact, the bid premia in those bids, where the arbitrageurs have to reveal themselves before the bid announcement date, are significantly lower than the premia in those bids, where the arbitrageurs do not have to. Finally, we find that arbitrage holding is not significantly related to the probability of bid success. The different results in the UK context comparing to the US confirm the importance of the anonymity assumption and the impact of the takeover regulation on the arbitrageurs' ability to influence the bid outcome.

Table 6.1: Description of variables for the arbitrageurs' role hypothesis

Variable name	Description	Data source
holding	*holding* is arbitrage holding measured as the percentage of target shares acquired by the arbitrageurs from the bid announcement date to bid resolution date. Arbitrageurs are defined as those who purchase the target shares after the bid is announced in at least 8 takeover bids in the sample	Perfect Filings
Outcome	*Outcome* is the bid outcome indicator variable, which is equal to 1 if the bid is successful and 0 otherwise. A cash bid is considered to be successful when the target is acquired. A stock bid is considered to be successful when the bidder, whose stocks are shorted by the arbitrageurs, acquires the target.	SDC
Premium	*Premium* is the bid premium measure as the sum of runup and markup. Runup is the cumulative abnormal return to the target shares for trading days (-40,-1) before the bid announcement date. Markup is computed as $(FP - P_{-1})/P_{-1}$ where P_{-1} is the target stock price one day prior to the bid announcement date and FP is the final offer price	SDC, Datastream
Hostile	*Hostile* is a dummy variable which is equal to 1 if the bid is hostile and 0 otherwise. *Hostile* measures the mood of the offer.	SDC
MultiBidders	*MultiBidders* is a dummy variable which is equal to 1 if two or more bidders are competing to takeover one target and 0 otherwise.	SDC
ManOwn	*ManOwn* is the managerial ownership measured as the percentage of target share directly owned by the target managers and their family. Managerial ownership is obtained from the target firm's most recent annual report prior to the bid announcement.	Perfect Filings (Annual reports)

Variable name	Description	Data source
LargeOwn	*LargeOwn* is the large shareholders' ownership measured as the percentage of target shares owned by the parties who have interest in 3% or more of the target shares. Large shareholders' ownership is obtained from the target firm's most recent annual report prior to the bid announcement.	Perfect Filings (Annual reports)
Stock	*Stock* is a dummy variable which is equal to 1 if the bidder stocks are used to pay for the target stocks and 0 otherwise. This variable represents the bid's method of payment	SDC
Toehold	*Toehold* is the percentage of target shares owned by the bidder at the bid announcement date	SDC
Irrevocable	*Irrevocable* is the percentage of target shares that a shareholder or a group of shareholders of the target firm commit to tender to the bidder	SDC
Scheme	*Scheme* is a dummy variable which is equal to 1 if the bid is conducted via a scheme of arrangement and 0 otherwise.	SDC
Termination	*Termination* is a dummy variable which is equal to 1 if the target agrees to pay the bidder the termination fee and 0 otherwise	SDC
TargetSize	*TargetSize* is the market value of target equity at the bid announcement date in 2007 GBP. The *UK Consumer Price Index – All Urban: All items* is used to convert target size to 2007 value.	Datastream
SizeTest	*SizeTest* is a dummy variable which is equal to 1 if the target's total asset at the bid announcement date is more than £70 million and 0 otherwise.	SDC
Relatedness	*Relatedness* is a dummy variable which is equal to 1 if the bidder and the target share the same 3-digit SIC code and 0 otherwise.	SDC

Table 6.2: Distribution of arbitrage holding and the number of arbitrageurs over the sample period

Years	Number of arbitrageurs					Holdings				
	Mean	25%	50%	75%	Max	Mean	25%	50%	75%	Max
1997	0.9	0.0	0.0	1.0	8.0	1.98%	0.00%	0.00%	0.84%	39.52%
1998	1.3	0.0	0.0	2.0	13.0	1.23%	0.00%	0.00%	1.53%	8.10%
1999	1.3	0.0	0.0	2.0	11.0	1.17%	0.00%	0.00%	1.12%	9.45%
2000	2.0	0.0	1.0	4.0	10.0	1.94%	0.00%	0.01%	2.53%	16.97%
2001	1.3	0.0	0.0	2.0	8.0	1.22%	0.00%	0.00%	2.54%	6.48%
2002	1.2	0.0	0.0	1.0	8.0	1.03%	0.00%	0.00%	0.94%	11.56%
2003	2.4	0.0	1.0	3.0	20.0	1.75%	0.00%	0.06%	1.93%	13.85%
2004	3.8	0.0	1.0	7.0	16.0	4.76%	0.00%	0.64%	6.13%	38.89%
2005	3.5	0.0	1.5	5.0	15.0	4.84%	0.00%	0.81%	7.42%	35.57%
2006	4.3	0.0	2.0	6.0	23.0	4.56%	0.00%	1.85%	7.34%	29.09%
2007	3.7	1.0	2.0	4.5	21.0	4.38%	0.04%	1.00%	4.37%	49.70%
Complete sample	2.5	0.0	1.0	3.0	23.0	2.73%	0.00%	0.05%	3.07%	49.70%

Table 6.3: Descriptive statistics of variables used in the arbitrageurs' role hypothesis

This table presents the descriptive statistics of the variables used in the arbitrageurs' role hypothesis. All variables are defined in Table 6.1. The statistics are reported for the whole sample and for two subsamples. The first subsample includes observations with arbitrage holding is greater than the median holding and the other includes the remaining observations. The result of the tests for the difference in mean and median between these two subsamples is also reported.

Variable	All	Greater than Median Holding	Less than Median Holing	Difference
	Mean [Median]	Mean [Median]	Mean [Median]	Mean [Median]
Managerial Ownership	11.06%	6.43%	15.67%	-9.24%***
	[3.23%]	[1.37%]	[7.55%]	[-6.19%]***
Large shareholders' ownership	38.5%	36.29%	40.71%	-4.43%***
	[39.65%]	[37.59%]	[41.9%]	[-4.31%]***
% of stock bids	19.3%	21.47%	17.13%	4.35%*
% of successful bids	89.13%	88.2%	90.05%	-1.85%
% having termination fee	10.57%	13.5%	7.65%	5.85%***
% with multiple bidders	15.16%	22.7%	7.65%	15.05%***
% of hostile bids	6.43%	6.44%	6.42%	0.02%
% with scheme of arrangement	10.26%	16.56%	3.98%	12.59%***
% with target's total asset > £70	47.63%	69.33%	25.99%	43.33%***
% with the same 3-digit SIC code	27.72%	27.91%	27.52%	0.39%
Toehold	4.57%	3.25%	5.88%	-2.63%***
	[0%]	[0%]	[0%]	[0%]**
Irrevocable Undertaking	16.55%	11.8%	21.28%	-9.48%***
	[0%]	[0%]	[1.54%]	[-1.54%]***
Target size (£2007)	377.6529	705.8028	50.5065	655.2963***
	[59.1347]	[24.0228]	[178.3138]	[-154.291]***
Arbitrage Spread	1.69%	0.98%	2.4%	-1.42%***
	[1.54%]	[1.01%]	[2.08%]	[-1.07%]***
Annualized Excess Returns	16.32%	12.09%	20.54%	-8.46%*
	[7.39%]	[6.6%]	[9.3%]	[-2.7%]*
Premium	35.79%	32.95%	38.63%	-5.68%**
	[28.88%]	[29.23%]	[28.34%]	[0.89%]

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 6.4: The relationship between arbitrage holding and arbitrage return

This table presents the estimation result of equation (33), which shows the relationship between the arbitrage holding and arbitrage return. All variables are defined in Table 6.1. $fittedholing$ is the predicted value of $holding$ in the first-stage regression, in which $holding$ is regressed against all other exogenous variables. Panel A reports the regression result. Panel B reports the F-statistic of the instrument variable $\ln(1 + Narb_i)$, $fittedholing^2$, the partial R^2 between $\ln(1 + Narb)$ and $holding$, the partial R^2 between $fittedholing^2$ and $holding^2$ in the first-stage regression under 2SLS and the result of Hausman test.. The figures in the parentheses in Panel A are the heteroskedasticity-consistent standard errors; the ones in Panel B are the p-value of the test statistics.

Panel A: Regression result			
	First stage regression	2SLS	OLS
Intercept	-0.0306*	-0.0053	-0.1033
	(0.0158)	(0.4233)	(0.4388)
Holding		2.9676	3.1792*
		(3.4606)	(1.6846)
Holding squared		-4.5988	-10.2877**
		(12.5189)	(4.6615)
ln(1+Narb)	0.0459***		
	(0.0032)		
LargeOwn	0.0079	0.1968	0.1936
	(0.0099)	(0.2192)	(0.2304)
ManOwn	0.0083	0.0592	0.0637
	(0.0130)	(0.2268)	(0.2472)
Hostile	-0.0024	0.5716***	0.5568***
	(0.0071)	(0.1672)	(0.1687)
Spread	-0.0264	1.7210**	1.6617**
	(0.0234)	(0.7734)	(0.7738)
MultiBiddersxStock	0.0362***	1.5300***	1.5931***
	(0.0140)	(0.5210)	(0.4970)
MultiBiddersxCash	0.0189***	0.3877***	0.4271***
	(0.0053)	(0.1013)	(0.0977)
Toehold	0.0188	-0.1866	-0.1749
	(0.0157)	(0.2272)	(0.2302)
Irrevocable	0.0046	-0.0287	-0.0287
	(0.0078)	(0.1205)	(0.1212)
Scheme	0.0119**	-0.0485	-0.0398
	(0.0059)	(0.1135)	(0.1104)
Stock	-0.0011	-0.0611	-0.0588
	(0.0046)	(0.1036)	(0.1025)
Termination	0.0017	0.0064	0.0219
	(0.0056)	(0.0727)	(0.0749)
ln(TargetSize)	-0.0041**	-0.1067**	-0.0971**
	(0.0018)	(0.0489)	(0.0441)
SizeTest	-0.0043	-0.0586	-0.0630
	(0.0045)	(0.0778)	(0.0783)
Relatedness	-0.0015	-0.0950	-0.1001
	(0.0038)	(0.0761)	(0.0770)
ln(Duration)	0.0076**	0.1006	0.1176
	(0.0033)	(0.0773)	(0.0792)
Adjusted R^2	0.455	0.135	0.145

Panel B: Other tests for the endogenous varaibles	
F-statistic - *ln(1+Narb)*	230.91
F-statistic - *fittedholding* ^{2}	92.56
Partial R^2 -*ln(1+Narb)*	0.4199
Partial R^2 -*fittedholding* ^{2}	0.2249
Hausman test	2.15
	(0.3406)

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 6.5: Bid premium and arbitrage holding

This table presents the estimation result of equation (36) which shows the relationship between bid premium and arbitrage holding. *DiscloseBefore* is a dummy variable equal to 1 if the arbitrageurs need to disclose their trading positions before the bid announcement date and 0 otherwise. All other variables are defined in Table 6.1. Panel A reports the regression result. Panel B reports the F-statistic of the instrument variable $\ln(1 + Narb)$, the partial R^2 between $\ln(1 + Narb)$ and $holding$ in the first-stage regression under 2SLS and the result of Hausman test. The figures in the parentheses in Panel A are the heteroskedasticity-consistent standard errors; the ones in Panel B are the p-value of the test statistics.

Panel A: Regression result						
	Full sample				Sub-sample	
	2SLS (I)	2SLS (II)	OLS (I)	OLS (II)	OLS - Before	OLS after
Intercept	0.524***	0.535***	0.532***	0.534***	0.335**	0.550***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.047)	(0.000)
Holding	-1.219**	-0.590	-0.752***	-0.647**	-0.628*	-0.834**
	(0.030)	(0.326)	(0.002)	(0.011)	(0.062)	(0.026)
DiscloseBefore		-0.0764**		-0.0754**		
		(0.019)		(0.015)		
LargeOwn	-0.0290	-0.0206	-0.0223	-0.0214	-0.0470	-0.00144
	(0.737)	(0.808)	(0.795)	(0.802)	(0.780)	(0.989)
ManOwn	-0.176	-0.177	-0.167	-0.178	-0.315	-0.152
	(0.199)	(0.194)	(0.225)	(0.195)	(0.132)	(0.347)
Hostile	0.0286	0.0187	0.0326	0.0185	-0.0866	0.0356
	(0.627)	(0.752)	(0.586)	(0.758)	(0.162)	(0.618)
MultiBidders	0.218***	0.204***	0.203***	0.206***	0.229***	0.174**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.013)
Toehold	-0.423***	-0.435***	-0.432***	-0.434***	-0.412**	-0.437***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.019)	(0.004)
Irrevocable	-0.130*	-0.132*	-0.127*	-0.132*	-0.0255	-0.166*
	(0.087)	(0.079)	(0.096)	(0.082)	(0.825)	(0.074)
Scheme	-0.0627	-0.0837	-0.0732	-0.0823*	-0.0632	-0.0848
	(0.210)	(0.100)	(0.125)	(0.087)	(0.361)	(0.182)
Stock	-0.104***	-0.114***	-0.107***	-0.113***	-0.0442	-0.129***
	(0.009)	(0.005)	(0.009)	(0.006)	(0.526)	(0.009)
Termination	-0.0564	-0.0528	-0.0597	-0.0526	-0.0323	-0.0684
	(0.170)	(0.191)	(0.143)	(0.198)	(0.596)	(0.218)
Ln(TargetSize)	-0.0153	-0.0161	-0.0205*	-0.0155	0.00612	-0.0182
	(0.213)	(0.195)	(0.067)	(0.172)	(0.787)	(0.178)
Adjusted R^2	0.061	0.070	0.065	0.070	0.107	0.048
N	653	653	653	653	187	466

Panel B: Other tests for the endogenous varaibles		
	2SLS (I)	2SLS (II)
F-statistic - *ln(1+Narb)*	219.93	207.42
Partial R^2 -*ln(1+Narb)*	0.2555	0.2448
Hausman test	0.78	0.01
	(0.3768)	(0.9164)

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 6.6: Probability of bid success and arbitrage holding

This table presents the estimation result of equation (37) which shows the relationship between the probability of bid success and arbitrage holding. All variables are defined in Table 6.1. Panel A reports the regression result. Panel B reports the F-statistic of the instrument variable $\ln(1 + Narb)$, the partial R^2 between $\ln(1 + Narb)$ and $holding$ in the first-stage regression under 2SLS and the result of Hausman test. The figures in the parentheses in Panel A are the heteroskedasticity-consistent standard errors; the ones in Panel B are the p-value of the test statistics.

Panel A: Regression result			
	Logistic Regression	OLS	2SLS
Intercept	3.5138***	0.9992***	0.9897***
	(0.8551)	(0.0529)	(0.0544)
Holding	-1.2471	-0.0174	-0.5184
	(2.7369)	(0.3002)	(0.5019)
LargeOwn	-0.3557	-0.0024	-0.0095
	(0.8390)	(0.0594)	(0.0577)
ManOwn	0.2876	0.0020	0.0080
	(1.4259)	(0.0638)	(0.0613)
Hostile	-1.8061***	-0.3119***	-0.3173***
	(0.4495)	(0.0782)	(0.0770)
Spread	-1.3900	-0.1169	-0.1081
	(3.9717)	(0.3092)	(0.3077)
MultiBiddersxStock	-2.5841***	-0.4819***	-0.4611***
	(0.8449)	(0.1146)	(0.1260)
MultiBiddersxCash	1.5854***	0.1079***	0.1229***
	(0.5920)	(0.0312)	(0.0345)
Toehold	1.2359	0.1064	0.1078
	(1.2422)	(0.0934)	(0.0920)
Irrevocable	4.5285***	0.1908***	0.1884***
	(1.4484)	(0.0419)	(0.0427)
Scheme	1.0480	0.0759**	0.0877**
	(0.6403)	(0.0371)	(0.0400)
Stock	-0.4233	-0.0428	-0.0401
	(0.3814)	(0.0360)	(0.0359)
Termination	0.2301	0.0149	0.0185
	(0.6423)	(0.0286)	(0.0291)
ln(TargetSize)	-0.2842**	-0.0283**	-0.0226*
	(0.1417)	(0.0115)	(0.0121)
SizeTest	-0.1714	-0.0032	-0.0034
	(0.3995)	(0.0275)	(0.0273)
Relatedness	-0.5133	-0.0433	-0.0458*
	(0.3231)	(0.0267)	(0.0264)
Pseudo/Adjusted R^2	0.267	0.205	0.199

Panel B: Other tests for the endogenous varaibles	
	2SLS method
F-statistic - *ln(1+Narb)*	214.31
Partial R^2 -*ln(1+Narb)*	0.2512
Hausman test	1.65
	(0.1993)

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Appendix 6.1: A Sample of Rule 8.3 Filing

RIS *from* Perfect Information Ltd

Number :	9748F	Date :	18/10/2007
Company :	STATE STREET GLOBAL ADVISORS	Time :	15:33:53

Rule 8.3- isoft group

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RNS Number:9748F
State Street Global Advisors
18 October 2007


FORM 8.3
DEALINGS BY PERSONS WITH INTERESTS IN SECURITIES REPRESENTING 1% OR
MORE
(Rule 8.3 of the City Code on Takeovers & Mergers)

1. KEY INFORMATION

Name of Person                State Street
   Dealing (Note 1)             Global Advisors & Affiliates
Company Dealt In              iSOFT Group PLC
Class of Relevant Security    Ord
   to Which the Dealings
   Being Disclosed
   Relate (Note 2)
Date of Dealing               17/10/2007


2. INTERESTS, SHORT POSITIONS & RIGHTS TO SUBSCRIBE



(a) Interests & Short Positions (following dealing) in
   the Class of Relevant Security Dealt In (Note 3)

Class of Relevant Security: Long                      Short
                            Number      %             Number        %
(1) Relevant Securities     2405457     1.04795
(2) Derivatives             390466      0.17011       0
0.00000
    other than options
(3) Options &
    Agreements to
    Purchase/Sell
Total                       2795923     1.21806       0
0.00000
```

(b) Interests & Short Positions in Relevant Securities of the Company (ex.Class Dealt In) (Note 3)

Class of Relevant Security:	Long Number	%	Short Number	%
(1) Relevant Securities				
(2) Derivatives other than options				
(3) Options & Agreements to Purchase/Sell				
Total				

(c) Rights to Subscribe (Note 3)

Class of Relevant Security: Details

3. DEALINGS (Note 4)

(a) Purchases & Sales

Purchase / Sale	Number of Securities	Price per Unit
BUY	390466	0.69
BUY	29509	0.69
BUY	18354	0.69

(b) Derivatives Transactions (other than options)

Product Name (e.g. CFD)	Long/Short (Note 6)	No./Securites (Note 7)	Price/Unit (Note 5)
CFD	LONG	390466	0.69

(c) Options Transactions in Respect of Existing Securities
(i) Writing, Selling, Purchasing or Varying

Product Name Type (eg call option) (e.g. USA, European etc)	Write,Sell Purchasing, Varying etc.	No/Securities Which the Optn Relates Relates-Note7	Exercise Price

Expiry Date	Option Money Paid/Received per Unit

(Note 5)

(ii) Exercising

Product Name (eg call option)	Number of Securities	Exercise Price per Unit (Note 5)

(d) Other Dealings (including new securities) (Note 4)

Nature of Transaction (Note 8)	Details	Price / Unit if applicable (Note 5)

4. OTHER INFORMATION

(a)Agreements, Arrangements or Understandings Relating to Options or Derivatives
Full details of any agreement, arrangement or understanding between the person disclosing & any other person relating to the voting rights of any relevant securities under any option referred to on this form or relating to the voting rights or future acquisition or disposal of any relevant securities to which any derivative referred to on this form is referenced.
If none, this should be stated.

Is a Supplemental Form 8 Attached? (Note 9)
NO

Disclosure Date	18/10/2007
Contact Name	Harshil Naik
Telephone Number	020 7698 6213
If Connected EFM Name of Offeree/Offeror With Which Connected	N/A
If Connected EFM State Nature of Connection (Note 10)	N/A

Notes:
The Notes on Form 8.3 can be viewed on the Takeover Panel's website at www.thetakeoverpanel.org.uk

Chapter 7: CONCLUSION

7.1 Introduction

Merger arbitrage, also commonly known as risk arbitrage, is the investment strategy designed to profit from the uncertainty about the final terms and outcome of a takeover bid. The literature review in Chapter 2 shows that the extant research on the determinants of the returns to the strategy falls into three hypotheses: the risk-based hypothesis, the limited arbitrage hypothesis and the arbitrageurs' role hypothesis. Two major themes in the risk-based hypothesis are how the systematic risk helps explain the arbitrage return and the risk-return characteristics of the strategy. As most studies report that the strategy can generate substantial positive abnormal return in excess of the systematic risk benchmark, the other two hypotheses namely the limited arbitrage hypothesis and the arbitrageurs' role hypothesis, are proposed to shed light on the source of the excess return or abnormal return. The limited arbitrage hypothesis looks at different types of costs, risks and constraints that the arbitrageurs in the real-world have to face in implementing the strategy. The arbitrageurs' role hypothesis examines different roles that the arbitrageurs play in the takeover process and the impact of these roles on the arbitrage excess return.

Based on the review of the incumbent literature, Chapter 2 identifies the gap in the literature. Except for the evidence that the arbitrageurs are able to earn significant positive abnormal return, the extant evidence about the risk-return characteristics of the strategy and about the limited arbitrage hypothesis and the arbitrageurs' role hypothesis is scanty, inconclusive and mostly limited to US samples. Interestingly, there is no empirical research on merger arbitrage in the UK market, the second most active merger and acquisition market in the world (after the US market). This represents the gap in the literature.

The aim of this research is to fill this gap by investigating the magnitude as well as the factors that determine the return to the merger arbitrage strategy in the UK market.

Furthermore, as the UK takeover regulatory regime is different from the US regime, this research can also uncover the impact of takeover regulation on the factors that determine the arbitrage return. To our best knowledge, this is the first study examining the linkage between takeover regulation and the determinants of merger arbitrage return.

On the basis of the three hypotheses about the determinants of merger arbitrage return we conduct three empirical projects testing these hypotheses in the UK market. Chapter 4 performs empirical analysis of the risk-based hypothesis. In particular, we estimate the risk-adjusted return to the strategy using a range of methods to control for systematic risk. We also examine the risk-return characteristics of the strategy and test the impact of the UK takeover regulation on the risk-return characteristics. Chapter 5 tests the limited arbitrage hypothesis in terms the impact of different types of risks, costs and constraints that the real-world arbitrageurs have to face on the arbitrage excess return. Chapter 6 examines the arbitrageurs' role hypothesis by looking at the relationship between the arbitrageur's holding of the target stocks and arbitrage excess return, bid premium and probability of bid success. Finally, this chapter summarizes the main empirical findings in Section 7.2, outlines the limitations of this research and some recommendations for future research in Section 7.3 and presents the contributions to knowledge and practice in Section 7.4.

7.2 Summary of empirical findings

This section summarizes the key findings reported in the preceding 3 empirical chapters.

Risk-based hypothesis – Chapter 4

Using a sample of 1105 UK takeover bids from 1987 to 2007, Chapter 4 demonstrates that the return in excess of the systematic risk benchmark to the merger arbitrage portfolios is significantly positive. The estimated risk-adjusted return is around 6.17%-7.44% per annum. Three asset pricing models are employed to control for risk: the Capital Asset Pricing Model, the Fama and French (1993) three-factor model and the Carhart (1997) four-factor model. The contingent claim approach to take into account the possible non-linear relationship between the return to the strategy and market risk produces similar result. This finding is consistent with the findings from other markets.

As far as the risk-return characteristics of the strategy are concerned, we first make an inquiry into the nature of the non-linear risk-return relationship. We find that one of the reasons for the existent of the non-linearity is that the bidder has economic incentive to renege on the bid during market downturn. Thus, given that the UK Takeover Code imposes much more stringent restrictions on the bidder's ability to withdraw from the bid compared to the US regulation, we conjecture that the non-linear pattern may not exist in the UK market. The result in Chapter 4 provides strong support for this conjecture. There is very little evidence that the UK merger arbitrage portfolios in the UK have positive market risk during market downturn and zero market risk during normal market condition. This finding, combined with the finding in the US market (strong non-linearity) and in Australian market (no non-linearity), shows the impact of the takeover regulation on the risk-return characteristics of the strategy.

Limited arbitrage hypothesis – Chapter 5

Using a sample of 653 UK takeover bids from 1997 to 2007, Chapter 5 tests the impact of different types of risks, costs, and constraints on the excess return to the strategy. We find very little evidence supporting the price pressure theory. The theoretical foundation of the theory is the agency-based limited arbitrage model proposed by Shleifer and Vishny (1997). Under this model, the capital-constrained arbitrageurs may not be able to absorb the selling pressure created by the target shareholders. As a consequence, the target stock may fall well below the efficient level enabling the arbitrageurs to earn abnormal profits. Employing two different proxies for the selling pressure namely target size and the abnormal trading volume, we find a negative relationship between the size of the selling pressure and the arbitrage excess return. This result runs counter to the prediction of the price pressure theory. Thus, this theory is not supported in our study.

We find strong supportive evidence for the arbitrage cost theory, which attributes the existence of the excess return to transaction costs and holding costs, two types of arbitrage costs that the real-world arbitrageurs have to face. With 4 different proxies for transaction costs, that is, firm size, price level, dollar trading volume, and frequency of zero return days, we find that transaction costs are one of the important determinants of the cross-sectional variation of the excess return to the strategy.

Holding costs, the other type of arbitrage costs, are found to have significant impact on the arbitrage excess return. As holding costs are the cost per unit of time, the finding that the excess return is increasing with the duration of takeover bid is consistent with the impact of holding costs. Idiosyncratic risk, one of the most important holding costs, significantly contributes to the source of the arbitrage return. We find that the arbitrage excess return is positively related to the variance of the estimated probability of bid success and bid premium, two proxies for idiosyncratic risk. Finally, using the bidder' institutional ownership as the proxy for short-sale constraints, we find that the costs of short selling appear to be another holding cost that the arbitrageurs concern about. The relationship between the bidder's institutional ownership and the arbitrage excess return is not statistically significant nevertheless. This may stem from the small sample size employed in the empirical analysis of short-sale constraints. Thus, the impact of short-sale constraints is still inconclusive.

Arbitrageurs' role hypothesis – Chapter 6

Using a sample of 653 UK takeover bids from 1997 to 2007 and a manually collected dataset to identify arbitrageurs and their holding of the target stocks, Chapter 6 tests the arbitrageurs' role hypothesis. In particular, we examine the relationship between arbitrage holding and arbitrage return, bid premium and the probability of bid success. We find that arbitrage holding is significantly related to arbitrage excess return in a non-linear way. Below a certain arbitrage holding threshold, the arbitrage excess return increases with arbitrage holding; above the threshold, arbitrage excess return decreases with arbitrage holding. The relationship between arbitrage excess returns and arbitrage holding remains significant after a host of factors that can affect the bid outcome and the market's assessment of the bid outcome are controlled for. This indicates that arbitrageurs are better than the average investors in the market in picking the best bids that yield higher risk-adjusted return for the arbitrage portfolios.

As for the relationship between arbitrage holding and bid premium, we find a significant negative relationship between these two variables. The finding is in stark contrast with the finding reported Hsieh and Walkling (2005) on a US sample as well as with the prediction of the theoretical model developed by Cornelli and Li (2002). The model is based on the premise that the arbitrageurs can hide their presence when accumulating the target stocks. The much more stringent UK disclosure rules during the bidding period compared to the US rules may contribute to this negative relationship and the different results between the UK and the US. If the bidder knows that the short-term arbitrageurs are already in the game, it would have no incentive to raise the offer price ex ante or revise the bid upward ex post to attract more arbitrageurs into the contest as predicted by Cornelli and Li (2002). In fact, the bid premia in those bids, where the arbitrageurs have to reveal themselves before the bid announcement date, are significantly lower than the premia in those bids, where the arbitrageurs do not have to.

Finally, we find that arbitrage holding is not significantly related to the probability of bid success. This finding is also different from the US study result as well as the prediction of the theoretical model. The finding about the relationship between arbitrage holding and bid premium and the probability of bid success suggests that disclosure rules during the bidding period have significant impact on the roles that the arbitrageurs play in the takeover process.

7.3 Limitations and recommendations

Like other empirical studies in finance, this doctoral research is subject to several limitations; hence, caution should be taken in interpreting the result. Future research on the determinants of merger arbitrage return should tackle these limitations to obtain more robust results.

First, the magnitude of the risk-adjusted return estimated in Chapter 4 is still subject to model misspecification problem. As argued in Chapter 2, to control for systematic risk, we need an asset pricing model that can capture the true risk-return relationship.

Unfortunately, to date, there is still no asset pricing model that can fully explain the cross-section variation of equity return. Thus, the anomalous evidence[35] that an investment strategy can persistently generate positive risk-adjusted return might just be a consequence of 'bad model' problem (Fama, 1991, 1998). Aware of this problem, in Chapter 4, we employ 3 different asset pricing models namely CAPM, Fama and French (1993) three-factor model and Carhart (1997) four-factor model to obtain robust result. Despite the effort, the 'bad model' problem cannot be resolved completely. Future research can improve the rigour of the risk-adjusted return estimation by incorporating the newly-developed asset pricing models. Growing attention has been paid to the recent development of liquidity based asset pricing models (see Pástor and Stambaugh (2003) and Liu (2006) for two examples of liquidity-augmented asset pricing models). In the context of merger arbitrage, Mitchell and Pulvino (2001) argue that the arbitrageurs are compensated for providing liquidity for the target stocks after the bid is announced. Thus, liquidity based asset pricing models are particularly relevant as the benchmark for systematic risk adjustment and therefore should be used in future empirical studies.

Second, the finding about the non-linear risk-return pattern in Chapter 4 may not be robust. Even though we have a large sample (1105 observations), the sample period is quite short comparing to the similar US study by Mitchell and Pulvino (2001). While the sample of the US study covers 37 years from 1963 to 1999, the sample in Chapter 4 only covers 21 years from 1987 to 2007. Further, and more importantly, our sample period coincides with the bull market period in the US and the UK (see Shiller (2005, ch.1) and Siegel (2007ch.1)). This may be the reason why we only find weak evidence about the non-linear risk-return relationship. Future studies should extend the sample period to cover the most recent downturn in the stock market to obtain more robust result.

Third, the accuracy of the proxies for selling pressure in the empirical analysis of Chapter 5 may be subject to further scrutiny. In an ideal world, the correct measure of

[35] See Schwert et al (2003) and Avramov and Chordia (2006) for a comprehensive review of the stock market anomalies.

selling pressure should be the volume of sell orders submitted by the sellers of the target stock. As we do not get access to the data on sell orders, imperfect proxies namely the target size and the abnormal trading volume of target stock are employed. As these proxies do not differentiate between the buy and sell activities, the result should be treated with caution. Future research should employ the correct measure of selling pressure to get better result.

Fourth, the empirical result about the impact of short-sale constraints in Chapter 5 may be driven by the small sample size and the biased measure of bidder's institutional ownership. The sample includes only 123 observations and in some tests, the sample size is reduced to only 102 because of missing data. The way we collect data on the bidder's institutional ownership, the proxy for short-sale constraints, produces biases in the measurement of this variable. The biases come from two sources. Firstly, because we only collect the ownership of the institutions, which have interest in 3% or more of the target equity, the institutions, which own less than 3% of the target equity, are left out. This creates a downward bias in the measurement of the variable. Secondly, when we collect data on this variable from the bidder's most recent annual report prior to the bid announcement date, the implicit assumption is that the bidder's institutional ownership changes very little over time. If the institutional ownership of the bidder firm varies significantly between the date, on which the bidder files the annual report, and the bid announcement date, our data do not accurate measure the institutional ownership of the bidder firm when the arbitrageurs sell short the bidder stocks. In such scenario, our data do not accurately measure the proxy for short-sale constraints. Future research should employ better dataset on institutional ownership to overcome this limitation.

Fifth, the empirical tests in Chapter 6 on the arbitrageurs' role hypothesis use a biased measure of arbitrage holding. As we only collect data on the holding of the arbitrageurs, who have interest in 1% or more of the target equity, we omit those arbitrageurs, who own less than 1% of the target equity. This produces a downward bias on the measure of arbitrage holding. Furthermore, even when we have a perfect measure of arbitrage holding, the empirical analysis in Chapter 6 is still unable to test the active role of the arbitrageurs. As the argument in Section 2.3.3 shows, the active role must be behaviourally observed. Thus, future research should make an effort to collect data on the activities of the real-world 'activist' arbitrageurs and examine impact of these activities on the arbitrage excess return. Bradley et al. (2010) make such effort in the context of closed-end fund discount arbitrage. In particular, the study investigates the factors that affect the likelihood that a closed-end fund gets attacked by a group of 'activist' arbitrageurs to transform the fund to open-end fund.

Finally, there is a lack of a solid explanation for the empirical findings about the relationship between arbitrage holding and bid premium, and the probability of bid success in Chapter 6. The theoretical foundation of the empirical analysis is the model developed by Cornelli and Li (2002). The model is predicated on the condition that the arbitrageur can maintain their anonymity when trading with other target shareholders. In the UK context, where the anonymity condition is unlikely to hold, a finding different from the prediction of the model is reported. However, since the extant theoretical model does not show what the relationship should be in case the anonymity condition is violated, we find it difficult to provide a solid explanation for the empirical findings. Thus, future research should advance the current model to incorporate the scenario, in which the arbitrageurs are forced to reveal their identity.

7.4 Contributions to knowledge and practice

This doctoral study explores the profitability of the merger arbitrage strategy and presents a comprehensive empirical analysis of the determinants of the arbitrage return for the UK market. Furthermore, this study provides empirical evidence about the impact of takeover regulation on the factors that contribute to the source of the return to the strategy. This study makes a number of contributions to the existing literature of merger arbitrage and contains several implications for practitioners.

First, using a large sample of takeover bids, Chapter 4 provides robust empirical evidence about the magnitude of the risk-adjusted return and the risk-return characteristics of the strategy. Prior to this study, other non-US studies only employ relatively small samples. The Canadian study by Karolyi and Shannon (1999) uses a sample of only 37 cash tender offers; and the Australian study by Maheswaran and Yeoh (2005) uses a sample of 193 cash mergers. In addition to the small sample size, these other non-US studies only employ samples of cash mergers. By using a large sample of 1105 takeover bids which includes both cash bids and stock bids, the simulated arbitrage return series generated in Chapter 4 closely mirror the real world.

The result in Chapter 4 is the first piece of rigorous empirical evidence to inform the academic community as well as practitioners about the profitability and the risk-return characteristics of the merger arbitrage strategy in the UK market. We show that the strategy is highly profitable on a risk-adjusted basis and has close-to-zero market risk. In other words, the strategy is approximately market neutral. The return series generated in this study can serve as the benchmark to evaluate the performance of the professionals who specialize in merger arbitrage. The main criterion to select takeover bids for the merger arbitrage portfolio in Chapter 4 is simply data availability. As a result, such a portfolio is accessible to any investor in the market. Thus, the professional arbitrageurs achieve superior performance that deserves their hefty fees only when they can outperform the arbitrage return series generated in this study.

Second, the empirical analysis in Chapter 4 shows how takeover regulation affects the risk-return characteristics of the strategy and provides supporting evidence. We argue that due to the restrictions on the bidder's ability to renege on the bid imposed by the UK Takeover Code, the non-linear pattern may not exist in the UK market. The evidence supports this argument. We find very little evidence that the return to merger arbitrage portfolio is positively related to the market return when the market is falling but has no relation with the market return in other market conditions. Our result shows the importance of regulation in shaping the dynamics of the risk-return relationship. The impact of regulation is often ignored in other research on the risk-return characteristics of various investment strategies. As regulation varies from country to country, the result in this study can be used as the baseline for future research to examine the same phenomenon in different contexts, which have distinctive regulatory settings.

Third, the empirical tests of the two competing theories namely the price pressure theory and the arbitrage cost theory under the limited arbitrage hypothesis in Chapter 5 help to resolve the conflicting evidence from the US studies. In the US market, Baker and Savasoglu (2002) report supportive evidence for price pressure theory but Officer

(2007) documents the opposite result. The finding in Chapter 5 shows no support for the price pressure theory. Our finding is consistent with the result reported by Officer (2007). The underlying assumption of the price pressure theory is that due to the opaque nature of the merger arbitrage strategy, it is very difficult for the outside investors to understand the ins and outs of the strategy. This assumption might not be true in the context of merger arbitrage as parties involved in a merger deal are required by the laws to disclose fair amount of information. The stringent disclosure rule under the UK Takeover Code reinforces the invalidity of this assumption. This result suggests that the price pressure theory may hold in other trading strategies, information about which is scarce, not in the case of merger arbitrage.

Fourth, while refuting the price pressure theory, the evidence in Chapter 5 provides strong support for the arbitrage cost theory. We report that transaction costs and holding costs, two types of arbitrage costs, are the important determinants of the return to strategy. The arbitrageurs require compensation for idiosyncratic risk, the most important type of holding costs. We also find that short-sale constraints are likely to contribute to the source of merger arbitrage return. These findings are consistent with the costly arbitrage literature and provide support for the Efficient Market Hypothesis, the mainstream paradigm in finance. The excess return to the merger arbitrage strategy is better explained by the additional costs and risks that the real-world arbitrageurs have to face than by the inefficiency in the pricing of merger stocks.

Fifth, the empirical evidence in Chapter 6 confirms the 'conventional wisdom' that the UK arbitrageurs are better than the average investors in the market. Though this finding brings no surprise because the arbitrageurs have a lot more resources to be better informed about the bid outcome and even have the ability to influence the bid outcome, most empirical research in merger arbitrage implicitly assumes that the arbitrageurs are the average investors in the market. There have been only two studies by Larcker and Lys (1987) and Hsieh and Walkling (2005) that detach from this assumption. And this study is the third.

Finally, the empirical findings in Chapter 6 about the relationship between arbitrage holding and bid premium and the probability of bid success convincingly demonstrate the impact of the disclosure rules during the takeover period. Because of the stringent UK disclosure rules, the arbitrageurs are forced to reveal their trading soon after they acquire the target stock. When their anonymity cannot be maintained, their presence actually reduces the bid premium and has no influence on the probability of bid success. These findings also confirm the importance of the anonymity condition for arbitrageurs to come into the game and influence the bid outcome proposed by Cornelli and Li (2002). The findings provide a solid ground for future work to advance Cornelli and Li's (2002) model to incorporate the situation when arbitrageurs cannot hide their trading.

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